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Artificial Curing of Forage Crops

By

Harold T. Barr

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C. T. Dowell, *Director*

Artificial Curing of Forage Crops

By

HAROLD T. BARR

The drying of some agricultural crops by the use of artificial heat has received increasing attention during the past few years. However, it is not a new process.

The first reference to artificial drying seems to be that recounted in "Horse-Hoeing Husbandry," by Jethro Tull, published in 1829.[1] Artifiicial heat was used in this case in order to reduce the moisture content in wheat, so as to store it for long periods of time, in order to sell when the price was high. One of the earliest attempts at artificial drying in the United States was for drying prunes about 1880, and then a few years later for the drying of walnuts.

The first[10] work in artificial curing of forage crops was carried on by the United States Department of Agriculture from 1910 through 1912, at Hayti, Missouri. In 1911, Arthur J. Mason built an experimental drier at West Point, Mississippi. He moved to the vicinity of Chicago three years later, where he continued his work. The Bayley Blower Company of Milwaukee, Wisconsin, in 1915, built a dehydrator for the McCracken Land Company of Houston, Texas.

The Louisville Drying Machinery Company, of Louisville, Kentucky, started experimental work about 1915. From 1915 to 1925, there seemed to be little interest along this line, with about the only work going forward being that of Mason and the Louisville Company, each of whom was making improvements on his dryers. During 1925, the interest in artificial drying gained momentum, and has been getting greater each year. The United States Department of Agriculture, state agricultural experiment stations, commercial companies, and various individuals have each put forth considerable sums of money, time, and effort in bringing about this development.

The importance of the hay crop in the United States is best shown by referring to the yearbook of the United States Department of Agriculture for 1934. A total of all crops harvested for 1933 is 327,324,000 acres, with 66,144,000 acres, or 20.20 per cent, devoted to hays. In Louisiana, in 1933, the total hay acreage was 202,000 with a farm value of $1,577,000. In the humid area of the Gulf States, the average monthly rainfall for the summer months is 4.56 inches. With this heavy rainfall, the production of the best quality of hay is an uncommon occurrence. It is not uncommon to have the quality of from 30 to 60 per cent of the hays in the Gulf States lowered one or two grades, or completely lost from rain damage.

Throughout the Gulf States there are large acreages which will produce heavy crops of hays, but they have only been partially developed because of the difficulty encountered in producing hay of good quality.

Artificial drying gives a better color, a more uniform product, higher protein content, and slightly higher percentage of leaves.[3]

	Color %	*Leaves %*	*Protein %*
Artificially cured	67	52	20.4
Field cured	60	48	19.5

The leaf loss and lower protein content are doubtless due to mechanical losses in the process of field curing. With alfalfa hay, Kisselback and Anderson[4] found that from 68 to 75 per cent of the total protein was contained in the leaves, varying some according to the stage of maturity, while work at the Louisiana Agricultural Experiment Station on soybean hays, carefully cured, shows the leaves to make up 59.7 per cent of the plant and the stems, 40.3 per cent of the plant. The leaves at the same time contained 4.78 times more crude protein than the stems.

With clear hot weather alfalfa or soybeans dried in the swath to a moisture content satisfactory for barn storage were badly bleached. In this condition, few leaves were lost if picked up by hand forks and loaded onto wagons; when raked into windrows, the ground in several cases was covered with leaves and fine stems.

Where hay is grown as a cash crop or commercial enterprise, a suggestion by Hurst and Kisselback[7] is that the value of the hay should be determined by comparison with the actual prices paid for the various grades at the terminal markets. They found that "a greater part of the alfalfa hay sold on the Kansas City market falls within No. 2 and No. 3 grades." In 1927 and 1928 the average price of U. S. No. 1 Extra Leafy Alfalfa was $8.01 higher than U. S. No. 2 on the Kansas City market. For the period of 1922-1932, according to the United States Department of Agriculture yearbook of 1933, the average price of U. S. No. 1 alfalfa was $4.12 higher than U. S. No. 2 at the Kansas City market.

With reasonable care, and allowing from two to four hours wilting in the swath before delivery to the drier, the hay from an artificial drier will grade U. S. No. 1, Extra Leafy.

Workers at other stations have found artificially cured hays to have several times as much vitamin A and vitamin E as similar hays cured in the sun. Vitamin D is lowered somewhat, perhaps due to the shorter period of exposure to the sun after cutting. In order to test out the effect of the curing process alone on the feeding value of soybean hay, two adjacent "cuts" of Biloxi soybeans of the same age and stage of maturity were cut. One-half was dried in the field, and the other half put through the artificial drier.

In order to be able to answer the questions as to the feeding value of the artificially dried hay, the Animal Industry Department[8] of the Louisiana Agricultural Experiment Station made a very careful study. "Four lots of calves were used in the test. Lot I was fed long soybean hay as it is normally fed. Lot II was fed field cured soybean hay cut or chopped the same as it is chopped for artificial drying. Lot III was fed the same amount of artificially dried hay as Lot II. Lot IV was fed artificially dried hay just as the calves would consume it." Their results were as follows: "1. One hundred pounds of artificially dried soybean hay was equivalent to 162 pounds of uncut field cured soybean hay in producing gains on calves. 2. Artificially dried soybean hay produced from 10 to 11 per cent more gains on calves and steers than cut or chopped field cured soybean hay. Two years' results showed artificially dried hay to be from 10 to 15 per cent more efficient in producing gains than field cured chopped soybean hay of the same quality. 3. Cutting or chopping reduced the waste of soybean hay about 40 per cent, probably because the steers eating the long hay consumed more leaves and refused more stems. 4. Artificially dried hay was more palatable than field cured hay."

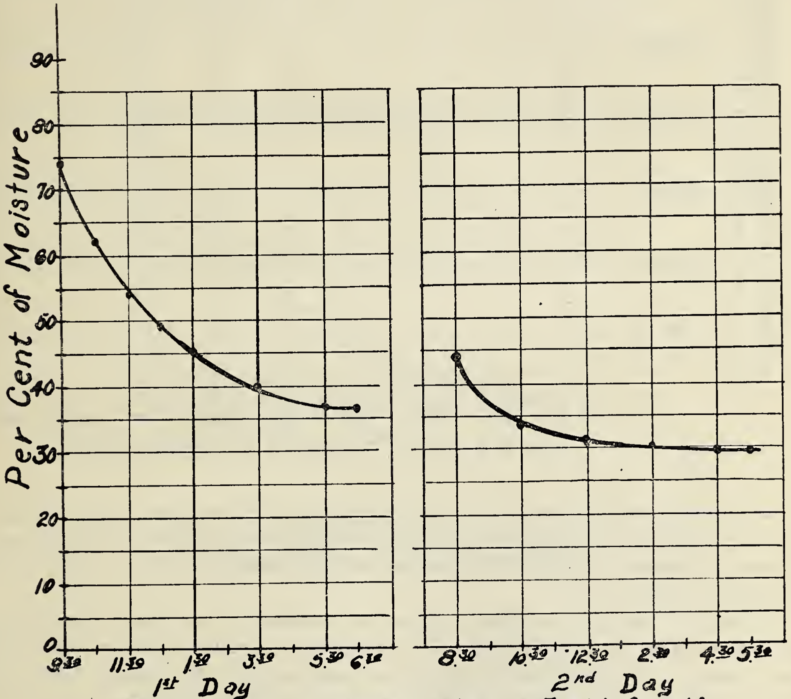
During five years' work in artificial drying, most of the experimenting was with soybeans, as this has proved the hardest crop to cure successfully, and is a widely used hay crop throughout the Southern States. Other hay crops and possible hay crops were cured artificially, and their relative feeding values given in Fig. I.

Fig. I

		ANALYSIS OF SAMPLE AS TAKEN							PER CENT OF DRY MATTER					POUNDS PER ACRE		
CROP—	DATE	Moisture as cut	Moisture after drying	Protein	Fat	N.F.E.	Fiber	Ash	Protein	Fat	N.F.E.	Fiber	Ash	Dry Matter	Protein	REMARKS
Green Soybean	Average of season	73.77		4.21	0.57	8.79	9.49	2.40								
Dry Soybean	"		9.56	13.38	2.27	30.21	36.09	8.49	14.77	2.48	33.50	39.89	9.30	3458	510.74	
Sun dried Soybeans	"		16.26	12.95	2.36	29.08	32.26	7.09	15.00	3.54	35.42	38.07	7.97			
Soybean leaves	"		8.38	16.19	2.05	23.58	13.27	36.57	17.66	2.23	25.73	14.47	39.91			
Alfalfa, green	"	76.79		4.35	0.62	9.49	6.45	2.30								
Alfalfa, from drier	"		7.58	13.53	2.47	36.17	31.35	8.90	14.64	2.68	39.14	33.91	9.63			
Alfalfa leaves, from drier	"		9.65	22.50	1.75	38.90	17.05	10.15	24.90	1.94	43.05	18.81	11.23			
Alfalfa stems, from drier	"		8.20	11.44	1.00	30.26	41.45	7.65	12.39	1.12	32.99	45.15	8.35			
Corn and Soybeans	"	75.38		3.05	0.68	8.75	10.02	2.12								
Corn and Soybeans	"		12.25	11.52	1.87	28.11	38.84	7.41	13.14	2.14	32.03	43.24	8.45	9812	1289.30	Corn in dough stage
Melilotus (Indica)		78.78		3.75	0.57	7.60	6.48	1.80								
Melilotus (Indica)			6.62	15.59	2.35	39.28	27.69	8.52	16.69	2.51	42.05	29.54	9.21			
Amaranthus		77.76		2.46	0.40	9.40	7.62	2.36								
Amaranthus			4.95	10.50	1.70	40.20	32.55	10.10	10.92	1.76	41.95	34.85	10.52			
Coffee Bean (Indiago)		63.61		4.42	0.95	13.72	15.88	1.42								
Coffee Bean			4.25	11.63	2.50	36.07	41.80	3.75	12.15	2.62	37.66	43.64	9.93			
Blood weed			7.58	9.06	1.05	42.41	28.40	11.50	9.79	1.15	45.89	30.73	12.44			
Cane pulp (dehydrated)			3.10	1.75	0.40	42.25	46.00	6.50	1.81	0.42	43.60	47.47	6.70			
Grasses*	First cutting								16.70	2.94	44.62	25.42	10.35	2946.2	478.75	Carpet grass: White Dutch clover, domestic rye grass, Lespedeza, Bermuda.
	Second cutting								13.76	2.09	43.01	31.87	9.61	1425.39	224.25	
	Third cutting								9.06	2.02	48.71	31.72	8.47	2556.09	197.90	

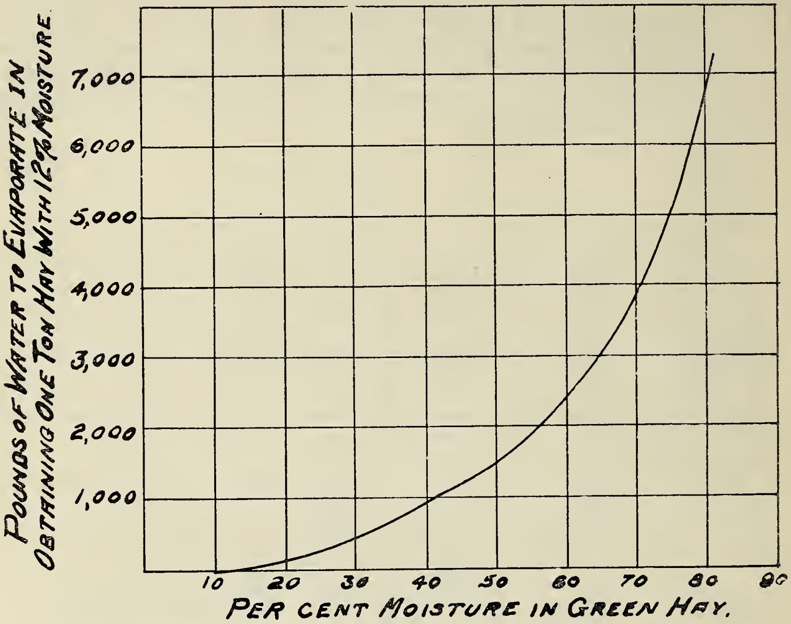
*See (10).

The principal hay crops are relatively high in moisture content when ready for cutting, and if brought direct to the drying plant necessitate the hauling of large amounts of moisture and at the drying plant reduce the total amount of dry hay that may be produced per hour. Each pound of water in the hay requires a definite amount of heat to raise its temperature from the temperature as delivered to the drier up to 212 degrees, and then evaporate this moisture. Each drier is built with a furnace capable of delivering a predetermined quantity of heat at maximum capacity. Hence, the dried hay capacity of the drier is normally this maximum heat, divided by the amount required to raise the temperature of, and evaporate, the moisture in green hay above that of the dried hay.



Moisture Loss in Soy Bean Hay in Field Swath

When hay crops are cut, they lose moisture very rapidly for the first four or five hours; then the rate of moisture loss slows up, as shown in FIG. II. Jones and Palmer[9] found similar results on Johnson grass and soybeans, but on alfalfa they found that the rapid loss continued from 7 to 8 hours. In curing a 250-pound sample (in the sun) of soybeans, it was necessary to leave the beans in the field four and one-half days in order to reduce the moisture content from 82 per cent to 17 per cent, with an average daily temperature of 88° F. by 10:30 a. m. With analyses from five years' work, the initial moisture content of green soybeans cut for hay ranged from 64 to 83 per cent, with an average of 74 per cent moisture. With a moisture content of 83 per cent, it is necessary to evaporate 8,353 pounds of water to leave one ton of 12 per cent hay, or requires hauling 10,353 pounds of green hay from field to drier. With 74 per cent initial moisture, 4,769 pounds of water must be driven off, and 6,769 pounds of green hay is needed. While with 64 per cent initial moisture, 2,888 pounds of water must be driven off, and 4,888 pounds of green hay is used (FIG. III).



By leaving the soybeans in the field from two to four hours after cutting, the moisture was reduced from 60-45 per cent, depending upon the time left in the sun and the stage of maturity. This is the practice as recommended for use in artificial drying of forage crops.

In order to remove artificially the excess moisture in the forage, heat must be supplied in rather large quantities. To evaporate one pound of water from 80° F. (temperature of hay delivered to drier) into steam at 212° F. requires 1,102 British Thermal Units. With forage in which there is an initial moisture content of 74 per cent, there is a necessary removal of 4,769 pounds of water to produce one ton of 12 per cent hay. This would require 4,769 X 1,102, or 5,255,438 British Thermal Units. With forage of 64 per cent initial moisture content, and the necessary removal of 2,888 pounds of water to produce one ton of 12 per cent hay, this would require 2,888 X 1,102, or 3,182,576 British Thermal Units.

With fuel oil containing 19,000 British Thermal Units per pound, and coal containing 14,000 British Thermal Units per pound and a theoretical efficiency of 100 per cent, the first case would require 276.6 pounds of oil, or 375.3 pounds of coal, while the second would require 167.5 pounds of oil or 227.3 pounds of coal to produce one ton of dried hay. Fourteen tests made on artificial driers in operation gave fuel efficiencies varying from 28 to 78 per cent. Leaving out two extremely low tests and one extremely high test, the average efficiency obtained was 63 per cent (FIG. IV).

ARTIFICIAL DRIER DATA

Fig. IV

		POWER		FUEL				LABOR *Man Hours*			
	DRIERS—	K.W.H. per ton of hay	K.W.H. per 1000 lbs. of water	Pounds of oil per ton hay	Pounds oil per 1000 lbs. water	B.T.U. per pound water evaporated	Water evaporated per lb. oil	Ton hay	1000 lbs. water	Moisture	Temperature °F.
1.	Apron	38	20	262	127	2413	7.66	6.96	3.2	60-12	250-300
2.	Apron	64	27	562	205	3895	4.88	10.85	3.6	60- 7	250-300
3.	Apron	58	24	310*	130.5*	1690	7.4	3.0	1.25	60-12	260-300
4.	Apron	70	29	385*	160*	2000	6.25	3.0	1.25	60-12	260-300
5.	Apron	115	24	660*	130.5*	1690	7.4	6.0	2.50	75-12	260-300
6.	Apron	140	29	310*	160*	2000	6.25	6.0	3.0	75-12	260-300
7.	Rotary	19	8	196	81	1620	12.3	4.0	1.67	60-12	1450
8.	Rotary	23	9.7	240	100	2000	10.0	4.0	2.00	60-12	1450
9.	Rotary	38	7.5	410	81	1620	12.3	8.0	3.33	75-12	1450
10.	Rotary	46	9	504	100	2000	10.0	8.0	4.00	75-12	1450
11.	Rotary	36	5.44	646	103	2008.5	9.9	8.0	1.30	72- 9	1500
12.	Rotary	25.6	4.94	372	72	1404	14.0	5.1	0.97	78-14	1850
13.	Rotary	27	5.26	516	113	2003.5	9.1	6.7	1.09	78-12	1600
14.	Rotary	29	10.00	213	100	1900	10.0	5.4	2.2	65-25	1000
“	Apron	38	21.00	316	170	3230	5.9	6.7	4.0	25-10	240

*Coal—B.T.U. per pound, 12,500. Oil—B.T.U. per pound, 19,500.

In 1927, work was started at this station by Messrs. C. L. Osterberger and J. J. Munson on artificial drying. Upon Mr. Munson's resignation, Mr. Carl Nadler worked for one year on the problem. Mr. Osterberger and Mr. Nadler resigned in 1929, and Mr. William Whipple and Harold T. Barr filled their places. The first drier was essentially a rectangular box, four by eight by forty feet high, on a framework of angle irons. The green material was chopped and blown to the top of the tower, where a set of baffles distributed it evenly over the top, allowing the material to fall off by gravity through a rising stream of hot furnace gases which entered the tower near the bottom. A given batch of hay was recirculated until the moisture was lowered sufficiently. Considerable trouble was encountered when the hay reached moisture contents just above the desired condition. It was hard to get the hay to travel against the stream of gases. Very low fuel efficiencies were also obtained.

In 1928, a single rotary drum drier three feet in diameter by twenty-eight feet long was tested out with very good results, but lacked capacity. From these results, a large drier was built in 1929.

The present drier which has been used successfully for three seasons is shown in Fig. V. The green forage is delivered to the ensilage cutter, chopped into short lengths (cutter set for 3/16-inch cut), elevated into the cyclone feeder, and fed by gravity into the high temperature end of the revolving drum. At this point, the green material comes in direct contact with furnace gases at a temperature of from 1600° F. to 1800° F.

An exhaust fan draws out the gases after they have been cooled by furnishing heat for the evaporation of the excess moisture at a temperature of 225° F. and maintained in the drum a current of air (400 F. P. M.) sufficient to carry out of the high temperature zone the particles of low density and therefore low moisture content. Repeated tests have been run which show the best temperature at the furnace end to be from 1600° F. to 1800° F., with an exhaust temperature of from 225° F. to 240° F. As soon as the drier is thoroughly warmed up the oil burners are set to give a heat of from 1600° F. to 1800° F. with complete combustion of the fuel.

Then the exhaust temperature is maintained or varied by the amount of green material (or moisture to be evaporated) fed into the high temperature end of the drum. This gives a very simple and practical method of controlling the moisture in the dried hay. The velocity of the flue gases carries the lighter portions through the drum in a few seconds while the heavier stems are picked up and dropped through the path of the hot gases until they lose their moisture. The entire drum is under a vacuum of about ½″ static water pressure maintained by the exhaust fan which helps to keep down the maximum temperature of the material as well as to reduce the amount of heat required for evaporation. At the entrance to the drum the chopped hay receives considerable heat by radiation from the flame and the incandescent brick work, so that the temperature of the material would be higher than the wet bulb temperature of the flue gases, and the rate of vaporization is increased above what it would be if shielded from direct radiation. The heat which must be supplied to the drying material can enter only through the surface, and cutting the hay into short lengths increases the ratio of dry to wetted surface and thus speeds up the rate of drying by exposing a greater possible surface to the hot gases. The high velocity of the gases past the wet surface of the material and the high mean temperature difference between the hot gases and green forage tends to speed up the drying process and give high evaporative capacity to this type of drier.

The drier as shown in Fig. V gave an average capacity of evaporating of 3,800 pounds of water per hour for two seasons. One test run of two hours evaporated 4,110 pounds of water per hour and a second test of one hour gave 4,400 pounds of water per hour.

The dried hay leaves the drier at an average temperature of 168° F., with exhaust gas temperatures of 230° F. with 10,030 pounds of dried hay in sacks stacked in a storage building the temperature in the hay reduced from 168° F. to 85° F. in twenty-four hours, with an outside temperature of 83° F. in the shade at the same time the final temperature reading was made in the hay. As the hay is discharged from the drier it can be sacked, baled, blown into a storage building, or conveyed direct to the mixer and the necessary molasses or other ingredients added to make a mixed feed.

With an average evaporating capacity of 3,800 pounds of water per hour an average efficiency of 55 per cent was obtained. This in turn required 41 gallons of fuel oil.

In producing one ton of dry hay from 74 per cent or freshly cut hay with a required evaporation of 4,769 pounds of water, 51.5 gallons of fuel oil was required and 1¼ hours to produce 1 ton of dry hay. When hay is left in the swath from three to five hours and is reduced to 64 per cent moisture and a required evaporation of 2,888 pounds of water, only 31.16 gallons of fuel oil are required and 1.3 tons of dry hay are produced per hour.

The amount of labor required to operate the drier will depend upon whether the hay is baled, sacked, or blown into a storage building. Successful operation has been obtained with three common and one semi-skilled laborers, when producing and sacking one ton of dry hay per hour.

The power required to operate the drier is distributed as follows: 10 horsepower to drive the ensilage cutter, 5 horsepower on the burner fan, 2 horsepower to revolve the drum, 1 horsepower on the oil pump, 1 horsepower for the conveyor screw, and 5 horsepower on the exhaust fan. If an elevating fan is used to store the dry hay, an additional 5 horsepower will be needed. For experimental work, individual electric motors were used, but for a permanent installation, a line shaft running lengthwise of the drum would be preferable, and one 30 horsepower electric motor, a 35 horsepower engine, or a tractor with 35 horsepower on the belt should be used.

A standard 16-inch ensilage cutter was used, but in order to secure a cut shorter than ½", an increased capacity, and a lower horsepower requirement, the following changes were made: To obtain a shorter cut (3/16-inch) a jack shaft was installed between the counter shaft and the lower feed roller shaft. Then for each 3/16-inch advance of the feed table, one knife passes the shear bar. To compensate for the slow feed table travel, the cutter was speeded up to 650 r.p.m. from a recommended 500 r.p.m. This increased speed gave a large increase in horsepower required, and to reduce this, 3 of the 6 fans were removed. The cutter thus modified was operated by a 10 horsepower motor and handled the material easily, as the maximum elevation is 12 feet.

In order to arrive at the cost of operation per ton of dry hay, the moisture in the green hay will be considered at the average for freshly cut hay. And thus the fuel required will be at the upper limit. With careful management and field wilting for 3 to 5 hours the fuel and power can each be lowered somewhat below the following figures. With any expensive piece of machinery in order to reduce the overhead cost per hour or ton of material, sufficient work must be available before buying the equipment. The following table is based on 500 tons of dry hay per season:

Drier depreciation, $3,500—10 years	$ 350.00
Interest, $\frac{\$3,500-\$350}{2}$ @ 6 per cent	94.50
Fuel, 51 gal. per ton @ 2½c X 500	637.50
Power, 22 K.W. @ 2c X 500	220.00
Labor—3 common @ 10c	150.00
1 semi-skilled @ 25c	125.00
Repairs 2 per cent of original investment	70.00
Total cost of drying 500 tons	$1,647.00
Total cost per ton of dry hay	3.29

FIELD OPERATIONS:

To get the complete cost of artificially cured soybean hay, records were kept for two years on all operations. An upright-growing Biloxi soybean has proven the best bean to grow for the drier in this locality. Drilling in rows 42 inches and 22 inches apart were each tried. The yield in each case was about equal; but the 22-inch rows gave smaller main stems and thus a slightly better grade hay. The average yield of dry hay was two tons per acre. Part of the field was operated with mule power and the remainder with tractor power as shown in the following table:

FIELD LABOR AND POWER SUMMARY

FIG. VI

	Disking		Planting			Cultivating			Mowing			Loading		Hauling		Unloading	
	T	M	T	Mule	M	T	Mule	M	T	Mule	M	Mule	Men	**			
2-Mule	.35	.38		1.24	.68		3.4	1.87		1.80	1.0	6.3	12.6	9.5	4.75	3.78	1.90
	.35	.38					3.1	1.70									
General Purpose	.35	.38				.72		.79									
				.50	1.10*				.70		.77	.63	12.6	9.5	4.75	3.78	1.90
Tractor	.35	.38				.435		.48									

Cutting with a power-driven corn binder increased the tractor work .30 hours per acre, and decreased the man hours 3.15 in loading and unloading. The bundled beans also decreased the labor in feeding the cutter; however, the bundled beans do not wilt down evenly, and the increased amount of fuel to evaporate this increased moisture will more than offset the gain from using the binder. Dump wagons or slings for unloading at the drier are recommended time savers.

TYPES OF DRIERS:

Driers in general may be classified briefly as follows:

1. Rotary drum (Louisiana State University, Ardrier)
2. Conveyor (Mason, Bayley, Fulmer)
3. Multiple Fan (Koon)
4. Tray driers
5. Tower driers
6. Stack driers

The first two types have proven the most successful with installations of each type scattered in various parts of the United States.

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*Two men with 4-row 22-inch planter.

**Hauling 1¼ miles and returning to field.

Rotary Drum Drier: The drier developed at Louisiana State University (FIG. V) is by far the simplest artificial machine drier, regardless of type.

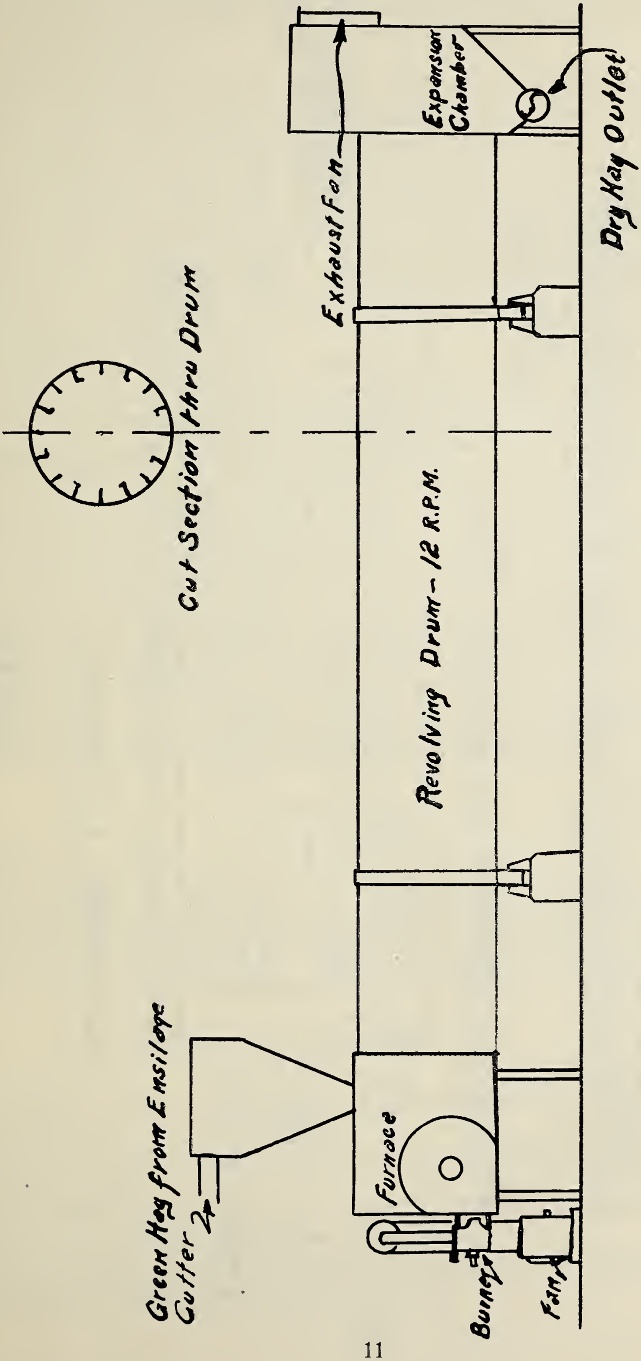
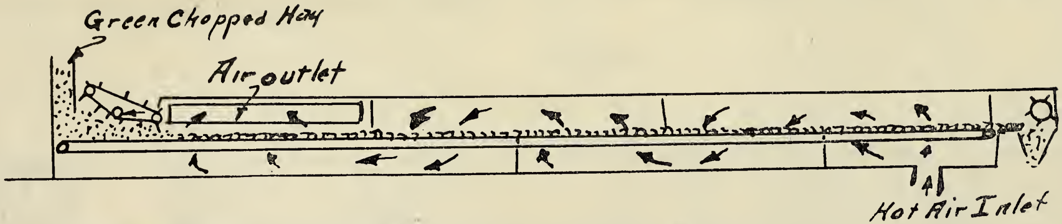
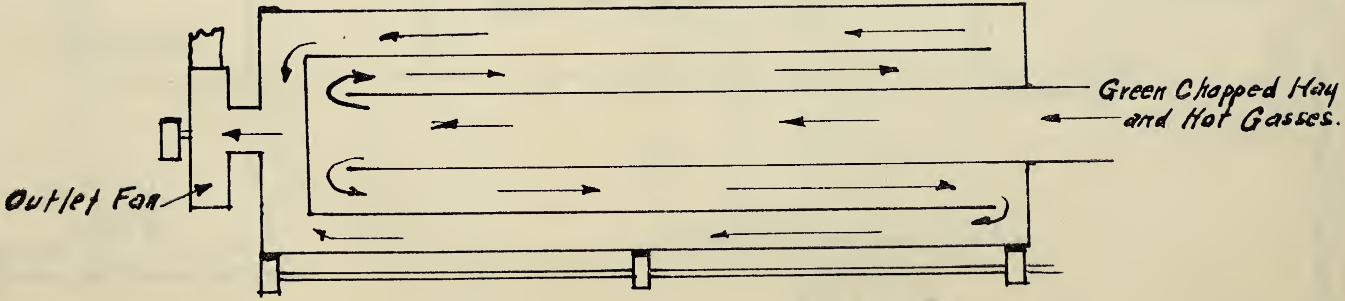


Fig. V.

A Larger Scale Drawing is Available to Those Desiring to Build a Drier.



General arrangement of a Conveyor Drier



Cut Section of Ardrier.

Fig VI

The Ardrier (FIG. VI) employs the same general principles as the Louisiana State drier, of air flotation, parallel passage of material and hot gases. The one difference is that it has three drums, one inside the other, which allows for a somewhat more compact unit. The characteristics of this type drier have already been covered in this bulletin.

Conveyor Driers: The first drier of any record in the United States was a conveyor drier, built and tried for three seasons, 1910 to 1912, at Hayti, Missouri. Later conveyor driers were built by Arthur J. Mason, Bayley Blower Company, and J. H. Fulmer. These driers consisted in the main of an endless apron for conveying the material to be dried through a tunnel where the green material is subjected to the hot drying gases. In this drier, the driest hay comes in contact with the hottest gases. They produce an excellent quality product, require a rather high horsepower, cost of drier is relatively high, and because of slow speed of conveyor, are difficult to adjust. If the material is drying too much or not enough, it is difficult to adjust quickly.

Multiple Fan: This type of drier was developed by A. W. Koon, of New Orleans, Louisiana. It consists of a series of fans, pipes, cyclone separators, and furnace. The green material and hot gases are mixed at the fan and blown up into a cyclone separator. Six fan and cyclone separator circuits comprise the travel ot the hay. Most of the gases are recirculated through the furnace. Each drier has been built differently from the former, and he now has a modified portable drier.

Tray, Tower, and Stack Driers: Each of these has been built with comparatively little success. The tray type is a batch process, having a relatively low capacity, and high labor requirement. The tower driers have employed gravity or conveyors to carry the material to be dried down through the drier over various baffles or shelves. Low capacity, low fuel efficiency, and in some cases recirculation to get the necessary moisture reduction have characterized this type drier. Stack drying has been used where a portable furnace and fan have supplied heat for drying material stacked around a central perforated pipe in the field. This type has given moderate success where only a small amount of moisture is to be removed.

ACKNOWLEDGMENT

The author wishes to acknowledge the work of C. L. Osterberger, Carl Nadler and J. J. Munson in beginning and carrying on the first two years of this work. To William Whipple, for his valuable assistance during three years of active tests as a co-worker, and to the Chemical Laboratory, Louisiana Agricultural Experiment Station, for all chemical analyses, thanks are also due.

SUMMARY

Artificial drying of hay crops is an economical and practical operation in the humid area.

Many acres now idle in the humid area can be used for hay crops by the use of artificial curing.

By artificial curing, a hay may be produced which is uniform as to color, odor, and food value, regardless of weather conditions.

Feeding trials with beef cattle gave faster gains on machine-dried soybean hay as compared to chopped field cured soybean hay.

Feeding trials have shown 2,000 pounds of artificially cured hay to be equivalent to 3,237 pounds of long field cured soybean hay for beef cattle.

Dairy cattle gave favorable results on artificially cured hays for each of the three years' tests.

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LOUISIANA BULLETIN No. 262

NEW INFORMATION ABOUT LIVESTOCK AND POULTRY

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C. T. DOWELL
Director

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FOREWORD

This bulletin gives summaries of the results obtained by the Louisiana Agricultural Experiment Stations during the last six years with livestock and poultry. Nearly, if not all of these results have already been published in bulletins by the Louisiana Station. The livestock and poultry farmer does not have time to read many bulletins. On that account, it was thought advisable to bring summaries of our investigations together in one publication. The reader will find not only the summaries but also, in some instances, formulae for the mixing of feeds and certain recommendations which are based upon results of investigations at this Station.

An index has been prepared in order that the reader may find the particular subject in which he is interested easily, if it is to be found in the publication. It will be the policy of this Station to prepare from time to time summaries of its work covering a year or a period of years. It is not thought to be advisable to include summaries of all of the work of the Station in one publication on account of the great diversity of interest of the farmers of the State. However, we have included the summaries of all of our investigational work during the last six years in livestock and poultry because we believe that all of the farmers in the State are interested in livestock and poultry.

It is planned to prepare three other summaries, one covering the work with sugar cane and rice, one fruit truck crops, and a third cotton, corn and forage crops.

C. T. DOWELL
Director

PART I

RICE BY-PRODUCTS FOR SWINE

C. I. Bray

The rice by-products are of considerable importance as feed for swine in South Louisiana. Brewers' rice is highly valued for fattening hogs. It produces a firm fat and showed somewhat higher value than corn in a number of experiments at the Iberia Livestock Experiment Farm. In one test at the Louisiana Experiment Station two lots of pigs averaged a gain of 1.88 pounds per day on brewers' rice, compared to an average gain of 1.62 pounds per day for two lots fed corn, both groups receiving a protein supplement. The hogs receiving rice ate slightly more of the rice than the corn group ate of corn. At $1.29 per bushel for corn ($46.00 per ton) brewers' rice showed a value of $48.45 per ton. Since repeal the demand for brewers' rice for manufacturing purposes has raised the price to such a high level that it is economical to feed this rice only when purchased directly from the mills in the milling season.

Rice bran and rice polish, while unsuited for feeding to fattening hogs in unlimited quantities on account of producing soft pork, can be used economically to replace a part of the corn in fattening rations. An experiment at the Louisiana Experiment Station showed that two lots fed a mixture of 75 parts corn and 25 parts rice bran produced an average gain of 1.31 pounds per day as compared with an average of 1.15 pounds per day on hogs of the same age and type, fed corn, both lots receiving protein supplements. On this basis, with rice bran fed with corn in the proportion of 1:3, the rice bran would show a feeding value of about $50.00 per ton, with corn at $46.00 per ton. This does not mean the rice bran has this high value compared with corn when fed alone, but illustrates the value of using limited amounts of low-priced rice bran to feed with high-priced corn.

In another test, in 1933, two lots of pigs were fed corn with one-third rice bran, compared with two similar lots fed corn and one-third wheat shorts. The rice bran appeared to have 96 per cent of the value of the wheat shorts which cost twice as much per ton. Comparing only the two lots that ran on Sudan grass pasture, the lot receiving the rice bran made gains equal to the lot receiving wheat shorts and put on gains for the same amount of feed.

PASTURES FOR BROOD SOWS AND LITTERS

Clean pastures are of particular importance for sows and young pigs in Louisiana. On account of the mildness of the winters and the early growth of spring pastures, it is possible to have good grazing for brood sows even before farrowing, and especially for the sows and young pigs after farrowing. To avoid parasitic infestation, it is best to use fresh pasture for the young pigs; that is, land that has been freshly plowed and seeded.

In one experiment in 1933, sows and pigs were run on white clover pasture, winter oats, rape pasture, and alfalfa pasture, in comparison with sows and litters fed in dry lot. The pigs gained 22 per cent faster on pasture and required less feed, while the sows maintained their weight better on pasture with less feed. The pigs were started at test at about 3 weeks of age and weened at 8 weeks. Each 100 pounds net gain in weight on sows and pigs cost $4.77 in dry lot, as compared with $2.32 on clover, $2.77 on alfalfa (1 sow only), and $3.20 on oats and rape. One acre of white clover pasture saved $9.11 in feed in 36 days at 1933 feed prices. At 1935 prices for feed, the saving would be over $21.00 per acre for the five weeks.

In recent tests at the Iberia Station, bred sows have been run on various winter pastures, which were disced in on corn stubble. Compared with sows fed in dry lot the sows on pasture required 38 per cent less feed to make the same gain in weight.

PASTURE CROPS FOR FATTENING HOGS

The use of pastures in fattening hogs is of particular importance in Louisiana. In the corn belt, on high-priced land, and with cheap corn, the use of pasture, while advisable, is not so necessary as it is in a Louisiana country of cheap pastures and higher priced corn.

In 1931, nine-tenths of an acre of good hog pasture of Sudan grass and Dwarf Essex rape replaced over one ton of concentrates (2134 pounds) in fattening thirty spring pigs in sixty-four days, May 31 to August 3. At present (1935) feed prices the value would have been over $40.00 per acre. In 1932, an acre of white clover pasture, with only ten pigs grazing, replaced 774 pounds of feed per acre, but as the acre would have carried 20 pigs or more, the value would have been at least twice as much. At 1935 feed prices ($40.00 per ton) with 20 pigs to the acre, the feed replacement value would be worth over $30.00 per acre. In 1934, at the Iberia Livestock Experiment Station, one-half acre of red clover pasture saved 488.4 pounds of feed in 56 days on 10 pigs. On the basis of gains produced, this would be at the rate of 1176.7 pounds of feed per acre. The clover would have carried at least six or eight more pigs, so that the total replacement value might be considered equal to nearly 2000 pounds of feed in two months.

It should be explained that these are estimated values, with the exception of the 1931 experiment, as in the later tests the pastures were not carrying so many pigs as they should have carried. The hogs on pasture ate as much feed as the others, the increased value from pasture coming from the increased gains. The feed replacement value is calculated from the additional amount of feed it would require for the dry lot hogs to make the same weight as the pasture hogs. It may be said that on this basis (an acre) a good legume pasture stocked to capacity will have a value almost equal to 1000 pounds of feed per month.

These values apply only to good, fresh pastures, preferably clover pastures, and not just any field of grass on which hogs may be pastured and which may be infested by parasites. Winter oats pastures and Sudan grass pastures have not shown such high values per acre but are still valuable, especially on land that would not be used for other purposes. In 1933, three half-acre pastures of Sudan grass replaced 384,293, and 164 pounds of grain feed respectively in 73 days. At $40.00 per ton for grain, this would indicate values of $15.40, $9.72, and $6.56 per acre at present feed prices.

IMPROVEMENT OF BEEF CATTLE BY BETTER BREEDING

The most economical method of developing good commercial beef herds in Louisiana is to breed up from acclimated Louisiana cows by the use of purebred beef sires. In 1924-25 a tract of land set aside for beef cattle work at Louisiana State University was stocked with common cattle, few of which showed more than 25 per cent of improved blood, if that much. Records of breeding and weights were kept from 1928 on. The average weight of the common cows in the herd was 789 pounds in November, 1928, and they would have graded fair to common. In November, 1932-33, the grade cows averaged 970-980 pounds, with the ¾ Herefords averaging 986 pounds, and grading good to choice in quality. It was estimated that at 1933 prices the improved cattle would have been worth $3.00 per 100 pounds as compared to $1.75 per 100 pounds for common cattle of the same age. At 780 pounds average weight for the common cattle this was $14.00 per head compared to $28.00 to $30.00 per head for the high grade cows or an increase of practically 100 per cent in value. Since 1935, beef prices are practically double what they were in 1933, so that the values for the same cattle in 1935 would be around $24.00 per head for the common cows and from $45.00 to $48.00 per head for the high grades. (For complete information write for Louisiana State Experiment Station Bulletin 244.)

HOGGING OFF CORN

Fattening hogs on corn and soybeans in the field has proved to be practicable and profitable when the fields can be economically fenced to hold hogs. Two experiments in 1931 and 1932 showed an average saving of 11.5 per cent of concentrates when allowing the hogs to gather their own corn in the field, when soybeans were planted in with the corn. The hogs gained 7 per cent faster in the field, the labor cost was much less, and all the fertility value from feeding went directly back to the soil. It was estimated that the soybeans saved approximately 200 pounds of feed per acre, besides adding to the fertility of the soil. At the Iberia Livestock Experiment Farm, in 1934, hogs fattened on corn and soybeans in the field made 7 per cent faster gains than hogs fed in dry lot, and the estimated amount of feed consumed was considerably less for the field-fed hogs.

BRAHMAN CROSSBREDS FOR BEEF PRODUCTION IN SOUTH LOUISIANA

Five years' records have been obtained on crossing beef cattle with a high grade Brahman bull of good type. It appears to be certain that in the Gulf Coast area there is an advantage to be obtained from the introduction of a certain amount of Brahman blood into commercial beef herds. Halfbred Brahmans and Quarter-Brahmans make a larger growth, especially as calves, than do cattle of similar age and out of similar cows, sired by bulls of the British breeds and containing no Brahman blood. Crossbred Brahman calves have regularly outsold the "beef type" calves of the same age on the New Orleans market. Even when the Brahman crossbreds bring a little less per pound, they have had a higher total value on account of their greater weight. Average Brahman crossbred calves weighed 490 pounds at weaning time as compared with 433 pounds for the "beef type" calves. Brahman yearling heifers weighed 733 pounds as compared with 649 pounds for the beef type heifers, and two-year olds weighed 1039 and 948 pounds, respectively.

Measurements of calves, after making allowance for the greater size of the Brahman half-bloods, show little material difference in body form, other than a little longer neck and body and from two to three inches greater length of leg. Quarter-bred Brahmans showed very little difference in measurement from beef type calves. Brahman grades are somewhat more nervous and difficult to handle than cattle with no Brahman blood, but growers accustomed to handling them find that this is not a material objection. They are better suited to commercial beef herds than to small farm herds, and are to be recommended principally in the Gulf Coast region. (For a complete report, send for Louisiana Experiment Station Bulletin 244 on Beef Production in Louisiana.)

FATTENING STEERS WITH GRAIN ON PASTURE

Six years of experimental work in fattening steers on grass, with a limited grain ration, have shown that profitable gains can be made and a very satisfactory marketable finish produced on pasture without feeding a great deal of grain. The gains made by feeding on pasture in summer have been more economical and profitable than gains on similar steers fed in dry lots in winter. The average gain for five years on steers fed grain and grass has been 2.18 pounds per day as compared with 1.55 pounds per day on grass alone over a three-year period. The average selling price for steers receiving grain, in 1928-29-30-31, was $9.36 per 100 pounds as compared with $7.97 per 100 pounds for steers on grass alone. When full market prices were paid for feed used, the grain-fed steers showed an average increase in profit of approximately $2.86 per head to pay for labor and feeding. With cheaper home-grown feeds, the profit would have been greater. This does not take into consideration that the extra fertilizing value of the feed used is returned directly to the land, and that the steers receiving grain do not require as much pasture as do steers on grass alone.

Fattening cattle with grain or grass appears to be a satisfactory method of finishing cattle in southern Louisiana. Since there is a heavy annual rainfall, producing an abundant growth of grass, the making of hay is a hazardous business, especially in early summer when the clovers are at their best. Summer fattening on grass saves concentrates and much of the labor of feeding; it also saves on the making of hay and eliminates the handling of manure. On account of the early grazing it is possible to put on a good light finish desired by the Southern market, by late June or July, when prices are usually more satisfactory than in the fall. The land is then available to produce at least one heavy cutting of hay by fall when there is a better opportunity to cure hay.

FEEDING SWEET POTATOES TO SWINE

Experiments in feeding sweet potatoes to swine were started in 1927 and continued five years. The Louisiana Experiment Station does not necessarily recommend the growing of sweet potatoes especially for hog feeding unless the making of the crop can be done largely by home labor, and eight to ten bushels or more of potatoes can be grown in place of each bushel of corn that would ordinarily be produced on the same land. When the No. 1 potatoes can be gathered and sold at a good price, it will pay to sell the marketable potatoes and let the hogs clean up the culls and jumbos. When heavy yielding varieties of sweet potatoes can be raised cheaply, the gathering of the entire crop by hogs may be recommended on account of the saving of labor.

A late crop of sweet potatoes is satisfactory for carrying hogs on into the winter after the corn is finished, especially if hogs are to be killed for home use in winter.

Some of the more important conclusions on feeding sweet potatoes are as follows:

1. Sweet potatoes must be balanced with some form of protein supplement. In the 1928 tests, each pound of tankage saved 45 pounds of potatoes, as estimated by feed required for 100 pounds gain. Pigs on sweet potatoes and tankage gained 1.46 pounds per day as compared with 0.87 pounds for the pigs on potatoes alone. A cheap protein supplement

for Louisiana is made up of 100 pounds shrimp meal to 50 pounds cottonseed meal. In 1929, an experiment showed that soybeans grown adjoining the sweet potato field could be used to supply protein, but the soybeans were not so satisfactory as was a protein concentrate fed to a similar lot.

2. Sweet potatoes appear to produce more economical and satisfactory gains in fattening hogs if the hogs are fed a one-third grain ration along with the potatoes. Potatoes are a bulky feed, and if hogs are on potatoes alone, they do not eat enough total dry matter to make rapid gains. When some concentrates were fed with the potatoes, only 4.3 pounds of potatoes were required to equal one pound of corn. (For further information, see Louisiana Experiment Station Bulletin 236).
3. Fresh sweet potato vines contain considerable protein and when the hogs have green vines to eat they consume only half the amount of protein supplement that they do when fed potatoes in dry lot or when the vines are dead after a freeze.

IMPROVEMENT OF PASTURES FOR BEEF PRODUCTION

One of the important agricultural problems receiving attention in recent years is that of pasture improvement. It is now realized that the productive value of much of our good land given over to pastures is as capable of increased production as land used for crop production. It is just as important to increase the production of milk and beef per acre of land when land is valuable and capable of improvement, as it is to increase the acre yields of cane or cotton. A great deal of Louisiana Land has excellent possibilities for grazing purposes, and is capable of producing higher yields of livestock products per acre if attention is paid to drainage, mowing weeds, improvement of grasses and clovers and by the proper use of fertilizers, when necessary.

In 1931, an experiment was started to determine the advantages of discing, seeding, and mowing black land not suitable for cultivation and used as pasture for beef cattle. In 1931 this land produced an average of only 69.4 pounds of beef per acre. The field was mowed regularly to kill weeds since the spring of that year, and drains were opened up. That fall the field was divided into equal parts and one-half was disced and seeded with six pounds White Dutch clover, nine pounds Red Top, and nine pounds Italian rye grass per acre. In 1933, the half that had been disced and seeded produced 264.8 pounds of beef per acre as compared with 148.6 pounds per acre for the half that had been mowed only. In 1931, another field on somewhat better land produced a total of 372 pounds beef per acre, showing the high value of Louisiana river land for beef production.

FEEDING GRAIN TO BEEF CALVES ON PASTURE BEFORE WEANING

Although this method of calf feeding is not a common one, there is some interest in this type of beef production on the part of those who are in a position to feed calves and who wish to sell calves of greater weight and higher sale value at weaning time. Four years of experimental work have shown moderate but consistent profits from this type of feeding during years when the feeding of large steers was generally unprofitable. The Louisiana market is principally a calf market and on many farms it is usually thought profitable to sell good calves at weaning time rather than hold them over, especially where there is no great amount of excess pasture.

Four experiments in creep-feeding showed an average of 50 pounds greater gains per calf, an average increase in value of 96 cents per 100 weight, or a total increased value of $6.90 per calf. The average cost of feed per head, at market prices for feed (1930-31-32-33) was $3.64 for 325 pounds feed per calf, leaving an average net profit of $3.05 to cover cost of feeding. If corn had been valued at farm prices there would have been approximately $2.00 increase in value for each $1.00 worth of feed used.

The average daily gain on grain-fed calves was 1.83 pounds, and for calves on pasture alone, 1.42 pounds.

These experiments have not shown so large profits as were reported in some other states during the period of high beef prices. Beef calves on good Louisiana clover make excellent growth on pasture alone, so that grain feeding does not produce so great a difference in size and finish as may be the case when the pastures are poor and the grazing season is short.

The advantages of creep-feeding are: (1) Getting more weight on the calves; (2) making them worth a higher price per pound; (3) keeping calves in good selling condition if pastures are poor. Whether or not one may practice creep-feeding profitably will depend on whether or not cheap labor is available to do the work; or whether or not the calves can be conveniently separated from the cows; and whether or not most of the feed is home grown. The profits from creep-feeding are not sufficiently large to pay for a great deal of overhead expense. (See Louisiana Experiment Station Bulletin 249.)

QUALITY OF GRASS-FED BEEF

One of the most important cooperative investigations of recent years has been the study of factors affecting the quality of meat:

One of these factors, the effect of grazing on the quality of beef, is of particular interest in Louisiana. It has been generally believed that the meat from animals fattened on grass was deficient in quality and flavor as compared with the meat from animals corn-fed in a dry lot. The results obtained by the investigators (including the Louisiana Experiment Station) indicate that there are no good grounds for discriminating against grass-fed beef. Grass-fed beef is not necessarily inferior in quality, texture, or flavor to grain-fed beef, if the cattle from which the beef is produced are of the same age, quality, and degree of finish. At this experiment station, in 1931, when steers on clover pasture alone made almost as much gain as did similar steers receiving grain in addition, there was no material difference in quality, color, or flavor of meat. In 1929, when the steers on grass alone made only half as much gain as those getting grain in addition, there was much more difference in quality. This indicates that the difference in quality is not due to the use of grass, but to the difference in finish or fatness.

Since Louisiana is principally suited to the growth of pasture grass, and since the market demand in Louisiana is for beef carrying a light finish, it is of considerable economic importance to produce as much of our beef as possible on grass alone or with a light grain finish following grazing. By using improved sires to produce animals of high quality, by improving pasture lands so as to have plenty of grass to produce rapid gains, and by wintering cattle in such a way that they will not lose most or all of their fat, it is possible to produce fine quality meat largely on grass.

LOUISIANA PROTEIN SUPPLEMENTS FOR SWINE

In growing and fattening swine, especially when the prinicpal feeds are corn, sweet potatoes, hominy feed, grain sorghums, brewers' rice, and other rice by-products, it is very important that the hogs have some protein supplement to balance their rations. Separated milk and buttermilk are ideal protein supplements when obtainable on the farm, but to the average growers they are usually not available in any large amounts. Clover pastures or green soybeans or cowpeas are also good supplements, but it is generally advisable to feed some protein concentrate in addition to pasture.

Shrimp meal, which is a by-product of the shrimp canning industry, in Louisiana, has proved in our experiments to be superior to tankage as a supplement to corn in feeding hogs. Tankage, a very popular and efficient source of protein for swine, usually sells at more than twice the cost of shrimp meal. In six comparisons of shrimp meal with tankage, fed both with and without other protein supplements, the hogs fed shrimp meal made 11.8 per cent higher gains than the hogs receiving tankage and the cost per 100 pounds gain has been 8 to 9 per cent less. A combination of equal parts of shrimp meal and cottonseed meal, two Louisiana feeds, produced slightly greater gains per day at lower cost than when shrimp meal was used as the only supplement. The shrimp meal and cottonseed meal mixture has also been superior to tankage and cottonseed meal.

A mixture of two parts of shrimp meal with one part of cottonseed meal is probably as satisfactory as any, though no experimental work has been conducted here on the proportions of the two feeds that will give best results. When one is located near a shrimp canning factory, it is probably more economical to use shrimp meal only, especially when cottonseed meal costs considerably more than shrimp meal. (Louisiana Experiment Station Bulletin 228.)

PART II

BLACKSTRAP MOLASSES FOR FARM WORK MULES

(Louisiana Bulletin 230)

M. G. Snell

A molasses mule-feeding project was started by the Louisiana Agricultural Experiment Station on June 3, 1929. This project ran for 62 days and then closed, being resumed on May 26, 1930 and continued to July 12, 1932. During these periods molasses was fed in varying amounts from 3.0 to 11.0 pounds daily, poured over ground hay or ground/whole ear corn (ground corn cob and shuck). The results obtained are summarized as follows:

Blackstrap molasses is equivalent to corn grain as a feed for farm work mules.

Blackstrap molasses increases the appetite of mules for other feeds.

Nine pounds seem to be near the maximum amount of molasses that can be fed to farm work mules with good results.

Heavy molasses feeding seems to increase sweating and "winding" of mules in hot weather.

When more than six pounds are fed, the molasses should be poured over the other grain feeds rather than mixed with them as a mixed feed because of the danger of fermenting. Mixed feeds which contain enough molasses to be moist may ferment during hot weather and become dangerous.

Treating mules for worms twice yearly is recommended.

The value of molasses as a mule feed in comparison to corn is shown below.

Corn, 56 pounds grain to the bushel;		Molasses, 11.7 pounds to the gallon	
Corn, per bushel	Molasses, per gallon, cents	Corn, per bushel	Molasses, per gallon, cents
$.20	4.18	$1.00	20.88
.25	5.22	1.05	21.93
.30	6.27	1.10	22.98
.35	7.31	1.15	29.02
.40	8.36	1.20	25.06
.45	9.40	1.25	26.11
.50	10.45	1.30	27.16
.55	11.49	1.35	28.21
.60	12.54	1.40	29.24
.65	13.58	1.45	30.29
.70	14.63	1.50	31.33
.75	15.67	1.75	36.56
.80	16.72	2.00	41.79
.85	17.76	2.25	47.01
.90	18.80	2.50	52.73
.95	19.85	2.75	57.46

Additional Molasses Information

Since the above molasses feeding work was completed, some eleven head of horses and nine head of weanling foals have been fed on a ration made up as follows:

Rice Bran	9 parts
Rice Polish	3 parts
Cottonseed Meal	4 parts
Total mixture	16 parts
Molasses	16 parts

In other words, the rice brand, the rice polish, and cottonseed meal were mixed up in the proportions of 9:3:4 and then mixed half and half with molasses. This ration is giving splendid results; however it has not been tried under experimental conditions. It is mentioned here because of its possible value to the cane and rice-growing areas.

New Molasses Work

Molasses feeding experimental work has been resumed by the Louisiana Agricultural Experiment Station and an attempt is being made to combine molasses and cottonseed meal in a ration suitable for work mules. As much as nine pounds of molasses have been fed satisfactorily by the Louisiana Station, and as much as six pounds of cottonseed meal have been fed by another station (Mississippi Delta Station); hence, the possibility of combining molasses and cottonseed meal for mules. These figures will be made available as quickly as they are accumulated.

DRY LOT CATTLE FEEDING

Cattle (steers and calves) have been fattened in dry lot for four different winters. The rations fed have included corn, molasses, brewers' rice, cottonseed meal, corn and soybean silage, grass hay, field-cured soybean hay, and machine-dried soybean hay.

The objects of these trials were to compare:

(1) The feeding value of corn and molasses when fed with and without silage.

(2) The feeding value of corn and soybean silage and hay.

(3) The feeding value of brewers' rice and corn.

(4) The feeding value of (a) long field-cured soybean hay, (b) chopped field-cured soybean hay, and (c) machine-dried soybean hay.

The results secured are summarized as follows:

Satisfactory gains were made with rations of ground whole ear corn full fed, cottonseed meal from 1.5 to 2.0 pounds daily, and grass hay self fed.

The addition of corn-soybean silage to a ration of ground whole ear corn, cottonseed meal, and grass hay increased the gains one year and decreased the gains the following year. The corn soybean silage used the second year was of poor quality, which may have accounted for the poor results.

The addition of molasses to the ground whole ear corn, cottonseed meal, grass hay ration, or the same ration containing silage increased the consumption of hay and resulted in better cleaning up of the grain feed, showing that molasses stimulates the appetite.

Molasses when added to a dry ration had about 94 per cent the value of ground whole ear corn; when fed in a ration with silage, its feeding value was about 87 per cent of ground whole ear corn. These figures show molasses to have a higher feeding value for cattle when fed in a dry ration than when fed with silage.

A review of the literature shows molasses to have a higher feeding value for fattening cattle when fed to the animal not to exceed three pounds daily than when fed in larger amounts of, for example, five pounds daily, to the animal.

In one trial with it, brewers' rice had a feeding value for fattening cattle of about 90 per cent that of shelled corn. In this trial, a ration of 7.22 pounds brewers' rice, 1.93 pounds cottonseed meal, and 7.45 pounds of grass hay was fed to 527 pound yearling steers. The average gain was 1.42 pounds daily.

Machine-dried soybean hay produced from 10 to 11 per cent more gains on both yearling steers and calves than did field-cured soybean hay of the same variety, grown on adjacent plots, and cut at the same stage of maturity.

Figured on its replacement value, machine-dried soybean hay was worth more at $15.81 a ton than field-cured hay at $12.50 a ton; on a percentage basis, machine-dried hay was worth from 59 to 71 per cent more than cut soybean hay with feed prices, as given in Louisiana Bulletin 257.

Cutting or chopping soybean hay saved approximately 40 per cent of the hay in producing gains. Calves getting long hay either consumed or wasted 47 per cent more hay than calves getting chopped hay.

Machine-dried hay is more palatable than field-cured hay and is consumed in greater quantities by both calves and steers than is field-cured hay.

Machine-dried hay is lower in fiber than field-cured hay, yet it does not take the place of concentrates in a fattening ration. Some attempts have been made to fatten steers or calves with a machine-dried hay feed in place of concentrates. Figures obtained by the Louisiana Agricultural Experiment Station show machine-dried hay to be a roughage, and not a concentrate; hence it should not be fed in the place of corn, brewers' rice, or other fattening concentrates.

MULE BREEDING

Animal Industry Circular No. 21

During the past seven years, eight mares on the University Farm have been bred to jacks. The first jack used was locally owned, and later a Missouri bred jack was used with these same mares. The data obtained on these mares and mules should be of interest to the Louisiana mule grower.

Mule Weights in Pounds

	Sire	
Age in years	Jack I	Jack II
1	-----	595
2	-----	813
3	822	925
4	921	1019
5	1019	------

The mules sired by Jack I averaged about 100 pounds lighter at the same age than did the mules by the second jack. The figures indicate that a good jack bred to native mares will produce mules of satisfactory size for cotton and sugarcane work.

That the mare plays an important role in mule production is shown by the following figures:

Mare weights, pounds	Mule weights at four years, pounds
1300	1083
1030	952
800 (saddle mare)	775

The 1300 pound mares were large framed, big boned, and rugged. Their offspring from both jacks were large enough and suitable for farm work. Likewise, the mules from the mares weighing around 1000 pounds were large enough for farm work, but mules from light-boned saddle mares did not attain sufficient size for farm work, especially when bred to a small jack.

For the most part, these mules were roughed through the winter on stacked hay. During two winters the hay plus some grain was weighed to the weanling foals. These foals consumed an average of 2.25 pounds of corn grain and 12.5 pounds of hay for a period of 76 days. The average wintering cost was $7.30 each, with hay at $10.00 the ton, and corn at 85 cents the bushel. These figures indicate the economy of raising mules under Louisiana conditions.

Summarized, these data indicate:

(1) That mules suitable for cotton and cane work can be raised from good jacks and native mares.

(2) That the jacks most suitable for mule production should be big boned and should weigh 950 pounds or more.

(3) That mares best suited for mule production should be rugged, heavy boned, and weighing 1000 pounds or more, preferably 1300 pounds or more.

(4) That young foals can be wintered in the open on grass hay but should have plenty of this type of feed if the best results are expected.

DRENCHING LAMBS

For three years lambs have been drenched with bluestone-Blackleaf 40 drench, and with bluestone and were compared with lambs which had not been drenched. No difference was found in the weights of these three groups of lambs. Drenching seems to be more effective in reducing egg production of internal parasites than in ridding the lambs of internal parasites. Under the conditions of this experiment, the lambs were drenched with a solution containing (1) one per cent of bluestone plus one per cent of Blackleaf 40; (2) one per cent bluestone, and (3) no drench. The drench was administered at the rate of 1.2 cubic centimeters of drench for every pound of body weight. Under farm conditions the following recommendations are made:

BLUESTONE-BLACKLEAF 40 FOR STOMACH WORMS

Have a druggist weigh out **40 grams** (approximately one-tenth of a pound) copper sulphate. Dissolve it in one gallon of water in a glass jar (do not use metal container). Add to this 40 cubic centimeters, or two 35-cent bottles, of Blackleaf 40. Use within 25 hours. This is enough for from 30 to 35 sheep.

To make 10 gallons, or drench for 300 head of sheep, dissolve one pound of bluestone in warm water. Add to this 400 cubic centimeters or 13 fluid ounces of Blackleaf 40. Add water to make up to 10 gallons. **Use glass or earthenware containers.**

Dose	Ounces	Coca-Cola Bottle
Grown sheep	4	2/3
Lamb	2	1/3

Dose	Ounces	Coca-Cola Bottle
Cow, mature	12 to 16	2 to 2 1/2
Yearling	6	1
Calf	4	2/3

Shut the animals in pen without feed or water for about 24 hours before, and from two to four hours after drenching, if possible.

Drench cattle and range sheep once or twice a year and farm sheep or sheep confined to small area, every 30 days, preferably every two weeks.

EFFECT OF FEED UPON WOOL, MILK, AND LAMB PRODUCTION

One of the results of the partial wool survey of the state was the discovery that about 25 per cent of the sheep in the cutover areas were shedding. This shedding apparently was not due to parasites, such as scab, or to disease but possibly to lack of feed. In order to determine whether or not shedding could be produced by lack of feed, a three-year experiment was carried on to determine the effect of the plane of nutrition upon the wool, milk, and lamb production of the ewe.

Lot	I	II	III	IV
	Full fed	Full fed 8 months, one-third full fed 4 months	Two-thirds full fed	One-third full fed
Ewes				
Initial weight, lbs.	68.4	68.2	68.4	69.1
Weight, 2 years later	111.8	97.8	79.1	52.4
Gain	43.4	29.6	10.7	—16.7
7-day milk production grams	257.0	170.0	160.0	76.0
Lambs*				
Ewes lambing, per cent	90.0	75.0	89.0	56.0
Lambs raised, per cent	90.0	71.0	85.0	75.0
Birth weight, pounds	7.27	6.60	7.73	5.33
120-day weight, pounds	52.60	38.0	39.3	28.3
Wool Production				
Weight, pounds	5.26	3.10	2.64	.9
Wool length, inches	4.30	3.69	3.61	2.81
Diameter, .0001 inches	9.36	9.62	8.39	6.61
Crimps per inch	5.70	7.43	7.03	8.40

*The figures obtained on Lot II lambs occurred when the mothers were on one-third full feed.

These figures show the ewes on a high plane of nutrition to produce more lambs and to be better mothers and better producers of wool than ewes on a low plane of nutrition. As would ordinarily happen under normal cutover conditions on the open range, the ewes full fed for eight months and then fed on a very low plane for about four months produced fewer lambs, less milk, lambs weighing less at weaning time, and less wool than did the ewes on a good ration the year around. The ewes on an extremely low ration were poor milkers, poor breeders, poor mothers, had light lambs at weaning time, and sheared very little wool.

The practical lessons to be drawn from these data are that year around care and attention will result in (1) thriftier ewes which are heavier milkers and better mothers; (2) an increased number of lambs being born; (3) a larger percentage of lambs being raised; (4) larger lambs at weaning time, and (5) heavier fleeces. Just how much care and attention each individual sheepman can give his sheep must be determined by each individual sheep and wool grower. The above figures may be of some assistance in his planning.

WOOL PRODUCTION

In the spring of 1931, wool was weighed from individual sheep in order to get some idea as to the wool situation as it actually existed. Some of the average wool weights are tabulated below by parishes:

Breed	Sex	Length, in.	Grease weight, lbs.	Scoured weight, lbs.
		East Baton Rouge Parish		
Native	ewes	3.37	3.46	2.29
Native	rams	3.26	4.07	2.58
Native	wethers	3.37	4.43	2.90
		St. Tammany Parish		
Native	ewes	2.76	2.36	1.40
Native	rams	2.89	3.78	2.29
Native	wethers	2.50	4.03	2.66
		Rapides		
Merino	ewes	2.14	11.88	4.51
½ Merino	ewes	2.89	6.74	3.65
Native	ewes	1.96	2.88	1.70

These figures show rather wide variations. The East Baton Rouge sheep sheared longer, heavier fleeces than did the St. Tammany sheep. This may have been due to the fact that the East Baton Rouge sheep had some Cheviot blood in them. The St. Tammany ewes sheared longer but lighter fleeces than did the Rapides parish sheep.

Some rather interesting figures were secured on purebred Merino ewes, half-blood Merinos, and native ewes in Rapides parish. The half-blood ewe sheared 6.74 pounds of wool, as compared to 2.88 pounds for the native. The first cross with a Merino ram has more than doubled the wool production of the first cross.

SHEEP BREEDING WORK

Inquiries frequently come to the University concerning the best type of ram to use with native ewes. Some of these inquiries come from people on bottom lands and others from people on cutover areas. Figures obtained by the Louisiana Agricultural Experiment Station are somewhat meager, but give some indication of birth weights, 120 day weaning weights, and the measurements of lambs sired by purebred Southdown, Hampshire, and Merino rams. These figures are summarized below:

	Sire				
	Merino	Southdown		Hampshire	
	half-blood	half	three-fourths	half	three-fourths
Birth weight, lbs.	7.3	7.9	7.95	8.4	9.2
Length, ins.	13.8	15.1	14.35	15.1	14.8
Girth, in	20.4	21.3	20.2	21.7	21.5
120-day weight, lbs.	39.3	55.3	51.2	57.8	60.2
Length, ins.	25.9	32.2	31.9	36.4	32.5
Girth, ins.	35.1	38.4	39.0	38.6	42.8
Yearling, ewes only					
Weight, lbs.	66.0	89.8		102.0	

PASTURE GAINS OF CATTLE AND SHEEP*

(Experiments 330 and 371)

Observations of the Louisiana Agricultural Experiment Station have shown a marked difference in the flora of pastures grazed by cattle and those grazed by sheep. In the cattle pasture, paspalum, white Dutch clover, and Bermuda were the chief grasses. "Jimson" weeds were more or less in profusion. Just across the fence, where sheep were grazed exclusively, the Jimson weed was conspicuous by its absence, the clovers were eaten to the ground, but the sedge grass was growing in more or less abundance. This suggested the possibility of beneficial results from grazing cattle and sheep together. This practice is looked upon with disfavor by the cattlemen, because, they say, the calves become infested with stomach worms from grazing on sheep pasture. Yet, in some areas of the state, cattle and sheep are grazed together with no detrimental results, apparently. Consequently, in order to shed some light on the question of grazing and parasitic infection, a grazing experiment was begun, the objects of which were to determine:

1. The acre gains of pastures grazed by (a) cattle exclusively, (b) sheep exclusively, and (c) cattle and sheep together.

2. The effect on pasture herbage of grazing with (a) cattle, (b) sheep, and (c) cattle and sheep together.

3. The effect on pasture gains of improving native pasture by discing and sowing with Italian rye grass and clovers.

4. The parasitic infection of calves and lambs grown under the three systems of management, namely: (a) cattle alone, (b) sheep alone, and (c) cattle and sheep together.

The following lots were used in this trial:

Lot I. Cows and calves grazed on native unimproved pasture.

Lot II. Cows and calves grazed on native pasture improved by discing and sowing with white Dutch clover, black medic, and Italian rye grass.

Lot III. Cows and calves and ewes and lambs grazed on native unimproved pasture.

Lot IV. Ewes and lambs grazed on native unimproved pasture.

Lot V. Ewes and lambs grazed on native pasture improved by discing and sowing with white Dutch clover and Italian rye grass.

The cows, calves, ewes, and lambs were weighed on three consecutive days at the beginning and at the end of the experiment, and once every 28 days during the experiment.

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*Acknowledgment is made to Dr. Roy L. Mayhew, Parasitologist, Louisiana Experiment Station, who made the parasitic studies reported in this paper, and to Prof. John P. Gray, Associate Agronomist, Louisiana Agricultural Experiment Station, for assistance in the agronomic studies.

Parasitic infestation was determined by (a) fecal egg counts in the case of the lambs, and by (b) examination of the intestinal tract of both calves and lambs at the close of the experiment, when these animals were slaughtered.

The effect of herbage was determined by cuttings taken from both protected and unprotected forage plots. Each pasture had three such groups, which consisted of (a) an unprotected plot, (b) a protected plot clipped once every 28 days, and (c) a protected plot clipped at the end of the grazing season.

Pasture Gains

The pasture gains are summarized below.

	I	II	III	IV	V
			Gain in weight per animal, pounds		
Cows	123	136	160	------	------
Calves	275	273	314	------	------
Ewes	------	------	27	2	4
Lambs	------	------	50	31.1	30
			Gain in weight per acre, pounds		
Cows	65	116	94	------	------
Calves	156	193	185	------	------
Ewes	------	------	19	2	6
Lambs	------	------	30	20	38
Total, pounds	221	309	328	22	44
			Marketable gain per acre		
Calves	156	193	194	------	------
Lambs	------	------	30	20	38
Total	156	193	214	20	38
			Value of marketable gain per acre		
Calf, @ 4c per lb.	$6.22	$7.72	$7.40	------	------
Lamb, @ 5.5c per lb.		------	$1.65	$1.11	$2.09
Total	$6.22	$7.72	$9.05	$1.11	$2.09

The total acre gains made by the different lots are as follows:

Lot 1. Unimproved cattle pasture, 221 pounds.

Lot II. Improved cattle pasture, 309 pounds.

Lot III. Unimproved cattle and sheep pasture, 328 pounds.

Lot IV. Unimproved sheep pasture, 22 pounds.

Lot V. Improved sheep pasture, 44 pounds.

The pastures which were improved by discing and sowing produced more gains than did the unimproved pastures. Lot II, the cattle pasture improved by discing and sowing, produced 309 pounds of gain as compared to 221 pounds of gain for Lot I, the unimproved cattle pasture. Lot II produced 193 pounds of calf per acre, as compared to 156 pounds in Lot I. The value of this marketable gain was $6.22 for Lot I, and $7.72 for Lot II, showing an increased income of $1.50 per acre as a result of discing and sowing. A comparison of Lot IV, unimproved sheep pasture, and Lot V, improved sheep pasture, shows the gains per acre to be 22 and 44 pounds respectively. The value of the lamb gains per acre was $1.11 and $2.09, respectively, showing an increased income of 98 cents per acre as a result of discing and sowing.

Lot III, which was grazed by cattle and sheep together, produced 328 pounds of gain per acre, which was 19 pounds per acre more than Lot II, the next highest gaining lot. Of this 328 pounds, 184 were calf gains and 30 pounds were lamb gains, or 214 pounds of marketable gains which had an estimated value of $9.05 per acre. This lot produced more marketable pounds than any other lot. Hence, grazing cattle and sheep together produced more gain per acre than grazing either cattle or sheep alone. Furthermore, grazing cattle and sheep together was more effective in producing gains than was discing and sowing.

Parasitic Infestation of Calves and Lambs

At the time of slaughter, all calves were examined for internal parasites. In addition, a group of 26 calves grown on the regular cattle pasture were examined at time of slaughter. These data are show below:

From these data, the sheep could not be accused of increasing the infestation of calves with internal parasites. Rather, it seems as if grazing sheep and cattle together, as in this experiment, results in a mutual benefit not only from the standpoint of gains, but also from the standpoint of parasitic infestation. One possible explanation of this is that internal parasites are "host specific", and that grazing cattle and sheep together reduces the number of animals of each species on the pasture, thereby lessening the opportunity of each species for infestation with parasites to which it is host.

One rather interesting question is raised by these figures. They show the lambs in Lots IV and V to be more heavily infested with internal parasites than Lot III. This is particularly true of the nodular worm. This brings up the question as to whether or not the differences in manner of grazing may not have some effect on parasitic infestation. The forage in Lot III, grazed by both cattle and sheep, was kept grazed comparatively close. There was no tall grass to keep the ground shaded and moist. In Lots IV and V certain of the grasses and clovers were grazed very closely, while certain of the other grasses reached a height of from two to three feet and kept the ground shaded during most of the summer and all of the fall. The question is raised as to whether or not this shading effect, together with the close grazing, might not be responsible in part for the increased parasitic infestation of the lambs in these lots.

The average number of nematode eggs found from examination of the feces was as follows: Lot III, 54 eggs; Lot IV, 81 eggs, and

	Initial Weight	Final Weight	Gain	Stomach Worm	Hook Worm	Nodular Worm	Whip Worm	Tape Worm
Average, Lot I	109	384	275	— to +	— to +	++	— to +	—
Average, Lot II	107	380	273	+	++	+++	— to +	—
Average, Lot III	101	415	314	— to +	+	+	— to +	—
Average, Non-experimental group				— to ++	— to +	++	+	— to +

Parasitic egg counts were made from the feces of the lambs at four different times during the year. At the time of slaughter each lamb was examined for internal parasites. These data are shown below.

	Post Mortem—October		
	Stomach Worms	Whip Worms	Nodular Worms
Average, Lot III (Lambs and ewes)	— to +	— to +	+
Average, Lot IV	— to +	— to +	+++
Average, Lot V	— to +	— to +	+++

An examination of the above figures shows both the calves and lambs grown in Lot III to be freer from internal parasites than the calves or lambs in any of the other groups.

Average percentage	Forage Studies of Unprotected Grazed Plots							
	White clover	Dallis grass	Bermuda grass	Broom sedge	Wild barley	Daisy fleabane	Weeds & Misc.	Cocoa grass
I. Cows and calves, unimproved	.53	10.75	53.89	.06			34.77	
II. Cows and calves, improved	.32	7.12	64.05			.16	27.36	.99
III. Cows, calves, ewes, lambs, unimproved	3.76	58.42	13.23		.05		24.54	
IV. Ewes and lambs, unimproved	.22	37.38	34.00	3.56	.34		24.50	
V. Ewes and lambs, improved	4.59	31.70	38.64	1.56	.29		23.22	

Summary

1. Native unimproved river front pastures will carry about one cow and calf to every two acres, or about one lamb and ewe to every acre.

2. Discing and seeding native pasture increased the carrying capacity per acre by about one-third, and the gains per acre by about one-half. Unimproved pastures produced 221 pounds of cattle gains per acre as compared to 309 pounds of cattle gains per acre produced on the improved pasture. Unimproved sheep pasture produced 22 pounds of gains per acre as compared to 44 pounds of gains per acre from improved sheep pasture.

3. Grazing cattle and sheep together on unimproved pasture produced the largest per acre gains of any of the lots and the heaviest calves and lambs of any of the lots. The per acre gains were 328 pounds, the calves averaged 415 pounds, and the lambs, 65 pounds.

4. The marketable gains (calves or lambs) per acre for the five lots were as follows: Lot I, 156 pounds; Lot II, 192 pounds; Lot III, 214 pounds; Lot IV, 20 pounds; and Lot V, 38 pounds. The values of the marketable gains were as follows: Lot I, $6.22; Lot II, $7.72; Lot III, $9.05; Lot IV, $1.11, and Lot V, $2.09.

5. Grazing cows, calves, ewes, and lambs together decreased parasitic infestation in both calves and lambs.

6. Grazing had a marked effect upon the forage produced. The lots grazed by cattle had comparatively high proportions of Dallis and Bermuda grasses; those grazed by sheep had comparatively large percentages of sedge grasses, while the lot grazed by cattle and sheep together had a comparatively larger proportion of clovers and Dallis grass than did the other lots.

Lot V, 168 eggs. In this connection it should be pointed out that in Lot III there was one ewe to every 1.4 acres; Lot IV, one ewe to every 1.3 acres, and Lot V, one ewe to every 0.73 acres. Fecal egg counts apparently are closely related to the number of sheep on an acre of ground.

The percentage of forage by weight as grown on unprotected plots is shown below. These figures show the variations in percentage of the forages grown on the unprotected plots from the various plots at three different seasons. The June cutting showed all lots to have considerable white Dutch clover, while the August cutting showed this clover to have disappeared, except in Lot III, the cattle and sheep pasture, and in Lot V, the improved sheep pasture. By November, white Dutch clover was present in Lot II, the improved cattle pasture; Lot III, the cattle and sheep pasture and Lot V, the unimproved sheep pasture. The pastures grazed by sheep, Lots III, IV, and V, had more Dallis grass and less Bermuda than the lots grazed by cattle, Lots I and II. Broom sedge and wild barley were found mostly in lots grazed by sheep. Broom sedge grew in profusion in the sheep pastures, Lots IV and V, but to a very limited extent in the cattle pastures, Lots I, II, and III.

PART III

POULTRY RESEARCH

Charles W. Upp

Storage of Louisiana Eggs

Studies were started in 1927 and continued until the close of 1931 to determine the storage qualities of Southern eggs. Several facts of importance were established by these experiments. Eggs produced in Louisiana on home-grown feeds keep in storage with entire satisfaction, if of good quality when stored. Getting eggs to market while strictly fresh is absolutely necessary if top prices are expected. Cottonseed meal is detrimental to egg quality, and is, therefore, not recommended for use in the laying mash. Eggs from hens fed rations containing rice by-products keep very well in storage. These results indicate that surplus spring eggs of this state could well be placed in storage and held for a few months until higher prices are prevalent (Louisiana Station Bulletin 229).

Rice By-Products in Poultry Rations

Five feeding trials involving 32 different lots of S. C. White Leghorn pullets and about an equal number of lots of chicks were used in these experiments, which extended from 1927 through the summer of 1932. As a result of this work in which varying kinds and amounts of rice by-products were used in poultry rations, the following recommendations are made. There is no good reason why wheat by-products should be used in poultry rations in sections of the state in which rice bran and rice polish can be bought at comparable prices. Likewise, oats or oat by-products and part of the corn meal recommended in many rations can be replaced by rice by-products. Rough rice is a good poultry feed and can be used in the scratch grain when local prices of this product are as cheap as, or cheaper than, other grains. Chicken feed rice (broken polished rice with more or less weed seed included) can be used also if of good enough quality. Brewer's rice is a very good feed, but prices in recent years have been too high to justify its use in poultry rations. The discovery of the particular value of rice bran as a preventive of perosis (a bone deforming disturbance) in battery or confinement grown chicks was made in the course of experiments at the Louisiana Experiment Station. The value of rice bran in poultry rations is recognized by feed manufacturers in other states; for example, two feed mills recently visited in Atlanta, Georgia, use rice bran as a standard ingredient in their poultry rations. It is to be regretted that many farmers and some feed manufacturers of Louisiana do not as fully appreciate the value of rice by-products in rations for chicks and for hens. Louisiana is deficient in the production of feed crops, therefore the best possible use should be made of feedstuffs that are produced locally. (Louisiana Bulletin 243).

Examples of an all-mash chick ration, a growing ration, and a laying ration that have given very good results at this station are listed below.

All-Mash Chick Ration[1]

42	yellow corn meal
15	rice bran or wheat bran
15	rice polish or wheat shorts
10	dehydrated shrimp meal or meat scraps
7	cottonseed meal
5	dried buttermilk
3	alfalfa leaf meal
2	pulverized oyster shell
1	pint cod liver oil (or equivalent in cod liver oil concentrate)
100	

Growing Mash[2]

39	yellow corn meal
20	rice bran
10	rice polish
10	shrimp meal or meat scraps
10	cottonseed meal
5	dried buttermilk
5	alfalfa leaf meal
1	salt
100	

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[1] Cod liver oil may be omitted from rations of chicks that run outdoors. If desired, scratch grain may be fed to the chicks after the first five or six weeks.

[2] If available, 1 per cent cod liver oil may be added to the growing mash. At this station "scratch" grain is hopper fed, allowing the growing pullets, after eight to ten weeks of age, free choice of grain and mash. Oyster shell and grit are also available at all times and the growingg birds have access to a green feed crop.

Laying Mash[3]

42	yellow corn meal
16	rice bran
16	rice polish
16	shrimp meal or meat scraps
5	dried buttermilk
5	alfalfa leaf meal
100	

Grain Mixtures for Growing Birds and Layers

No. 1

50	yellow corn
50	chicken feed rice or rough rice
100	

No. 2

35	yellow corn
30	wheat or heavy oats
35	chicken feed rice or brewers' rice
100	

Does Heavy Egg Production Affect Hatchability

The opinion is quite prevalent among poultrymen that heavy egg production prior to and during the breeding season is detrimental to the hatching quality of the eggs. A study extending over three years and involving White Leghorn, Rhode Island Red, and Plymouth Rock breeders showed that low hatchability was not associated with heavy egg production. The fertility of the eggs was somewhat lower for the heavier producers. These results suggest that breeding birds need not be held back in production.

Simple vs. Complex Rations

Farmers often feel that recommended poultry rations contain too many ingredients. Simple rations (few ingredients) were compared to more complex rations for two years, and the results indicate that birds lay better on a ration containing a larger variety of feeds. However, hens fed the simple ration produced approximately twice as many eggs as the average hen in the State. This demonstrates that even a simple ration with adequate protein content will produce fair results.

Control of Mites

The value of "Crewood Oil" (a by-product of wood distillation) in the control of mites in the poultry house was tested for two years. Badly infested houses were treated thoroughly and the mites were exterminated. No mites could be found when examination was made more than a year after treatment. These tests were conducted with funds made available by a commercial concern. Waste oil or kerosene may be used also to treat houses for mites, but more frequent treatment is required with these materials.

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[3] It is the usual practice to limit the grain feed of layers so that about equal amounts of mash and grain are consumed, but poultrymen vary this according to their judgment and to the physical condition of the birds.

Comparison of Management Methods of Young Stock and Mature Birds

Three years' experimental work was conducted in which chickens were grown and kept under a variety of conditions in an attempt to control diseases and parasites. Some lots were kept in extreme confinement; that is, they were grown out in battery brooders and kept as layers in individual laying cages. Other lots were brooded on litter and placed in the laying houses when 12 weeks of age. Several intermediate conditions of management were also tried. The plan of management recommended as a result of this work is given.

Wire floors are used in the brooder house and on sunporches until the chicks are from 8 to 12 weeks of age (chiefly to control coccidiosis). At this time they are moved to a three-year rotated growing range upon which a tender green feed crop is available. Just before the pullets are ready to begin laying they are moved to laying houses which have double yards. A green feed crop is growing at all times in one of the two yards. The pullets are given an individual worm treatment at the time they are moved to the laying house. All pullets are vaccinated against fowl pox (sorehead) not later than June 1, regardless of the date hatched, to forstall chicken pox outbreaks which are common soon thereafter. If chicken pox has never occurred on a farm it is not necessary to vaccinate, although if the disease is prevalent in that community it is safer to do so. The above precautions are not so essential if only a small home flock is kept. With small flocks and the chickens ranging over the farm, it is advisable to have movable brood coops and a movable laying house and to **move these to new locations frequently.** The brood coops should be moved at least once a week and the laying house several times a year. These methods aid a great deal in controlling diseases and parasites. Confinement of mature birds is not recommended as a general practice, but conditions in some instances warrant the use of complete confinement. (Bulletin in preparation).

Control of Cannibalism

Cannibalism is at times quite a problem when chickens are kept in confinement. No formal experiments have been conducted to control this vice, but it was necessary to use measures to control it in connection with the management experiment.

Several practices have proved to be of value in controlling cannibalism, avoidance of overcrowding being of primary importance. Two of the most practical things to do to prevent cannibalism in young chicks are: (1) to provide subdued light, and (2) if artificial light is provided, use low power, red (or ruby) tinted bulbs. Light in the house may be subdued by covering windows (at least partially) with one layer of burlap from feed sacks, by painting windows with bright red paint or by using red celoglass instead of window glass. Similar measures may be used in laying houses, although precautions must be taken to avoid interference with the circulation of fresh air.

Layers in confinement may be kept busy by such devices as providing green feed suspended by wire stuck on nails in the wall, placing feed in racks, or by feeding scratch grain in the litter. Secluded nests will also aid in the control of this trouble, and trimming beaks will serve as a temporary aid. As a last resort, protectors may be made or head guards used in severe outbreaks of cannibalism. Pinetrel or other creosol compounds will discourage further attacks if applied liberally to parts affected.

Blackstrap Molasses in Poultry Rations.

It seems impractical to expect farmers to mix blackstrap molasses in poultry rations, and the practice probably will not be generally adopted; however, mixing blackstrap by hand has proved to be easier than expected in experiments covering the past three years. A molasses mixing machine was used until destroyed by fire, since, which time all mixing has been done by hand by means of screen sieves. Molasses mixing machines are used by many feed manufacturers. The last year of these experiments has not been completed, but general observations can be made concerning the use of blackstrap molasses in poultry rations. This product has been used in chick rations, laying rations, and fattening rations. When molasses composes more than 5 per cent of an all-mash chick ration, the chicks do not grow as fast or as uniformly. Fifteen per cent molasses causes considerable mortality and the chicks make very uneven growth.

Laying hens fed rations containing 7.5 per cent molasses of the total ration (or about 15 per cent of the laying mash) produce as well and are somewhat heavier than hens fed similar rations which contain no molasses. Rations containing as much as 10 per cent molasses (of an all-mash ration) have been fed with fairly good results, but the droppings are very watery and the litter gets damp and soiled quickly. Flies collect in the heavy, molasses-fed pens.

Gains of from 25 to 40 per cent have been made by 8-week old cockerels in fattening tests extending over a two-week period. The rations containing 10 and 15 per cent molasses have both yielded good results. About 10 per cent gains were made by hens during 10-day trials.

Shrimp Meal as a Protein Supplement for Chickens

Shrimp meal was used for two years in preliminary tests with laying hens. During the past three years, chicks, growing stock, and hens have all received rations containing shrimp meal. Sun-dried shrimp meal (i. e., the by-product of sun-dried shrimp) was used first in 1934 and is being used again this year. Sun-dried shrimp meal is allowed a maximum of 7 per cent salt, according to a state regulation, but samples run as high as 10 per cent salt. Farmers purchasing shrimp meal should be aware of the kind of shrimp meal bought, because the feeding value of sun-dried shrimp meal for poultry is considerably less than steam-dried (or other unsalted) shrimp meal.

Steam-dried shrimp meal will satisfactorily replace cottonseed meal, meat scrap, or corn gluten meal in chick rations. When shrimp meal replaced dried buttermilk, growth was somewhat retarded. Since shrimp meal is high in mineral content, precautions should be taken to avoid feeding an over supply of minerals. (See rations given in section on feeding rice by-products.) Sun-dried shrimp meal is not recommended for chick rations. In chick rations and growing rations, shrimp meal can be used as the only source of protein, but better growth is obtained when more than one protein feed is included. When sun-dried shrimp meal replaces meat scraps to the extent of 15 per cent of an all-mash laying ration (equal to about 30 per cent of the mash if grain is fed separately), the hens do not lay quite so well, and the droppings are watery, owing to the high salt content of the meal.

Steam-dried shrimp meal, on the other hand, may replace one-half or all of the meat scrap with entire satisfaction. Shrimp meal as the sole source of protein produces fairly good results, but not equal to rations which contain two or more protein feeds. Shrimp meal should, and no doubt will, be used more widely in poultry rations in this State.

Hatchability Studies

Extensive examinations of eggs that failed to hatch show that breeding is a very important factor in hatchability. These examinations in conjunction with inheritance studies have made possible the elimination of certain inherited defects from the breeding stock. These results stress the need for an importance of trap-nesting and pedigree hatching in a real breeding program. (Louisiana Bulletin 255).

Improvement by Breeding

Permanent improvement of the flock is dependent upon breeding stock prepotent for livability, high production, large egg size, good body weight, and other desirable inherited characters. It is practically impossible to obtain such stock without a carefully planned breeding program which entails exacting record keeping.

Complete breeding records have been kept since 1929, and considerable progress is being made. The National Plan of Poultry Improvement which becomes effective in July, 1935, will do much to improve breeding stock throughout the state by giving recognition to supervised breeding work done by individual poultrymen.

Electric Heat for Battery Brooders

Based upon a rating capacity of 21 sq. in. per chick, the average power consumption per chick brooded to 4 weeks of age, in a room with supplemental heat, was slightly more than 1 k. w. h. The records were based upon three six-compartment brooders for one season, February to May, inclusive. The cost is not excessive when reasonable rates are available. (Report of Louisiana Agricultural Experiment Station, 1931-1933).

Sweet Potatoes for Chickens

During the current year sweet potatoes are being fed raw to one pen of hens, and cooked to another pen. The hens getting the cooked potatoes eat many more potatoes than those receiving raw ones. The sweet potatoes are fed to replace green fed, and the egg production has been entirely satisfactory for this season. More extensive tests are planned in which sweet potatoes will be fed to chicks and to hens.

PART IV

DAIRYING

R. H. Lush

The ultimate goal of the station regarding dairy work is to determine maximum utilization of Louisiana feeds and pastures for more economical production of good milk products. Reports of work done here show much progress attained.

Rate of Grain Feeding: To determine the economical amount of grain to feed milk cows on good pasture in summer, or on legume hay and silage in winter, varying amounts of grain were fed for three years. The results show that with a good milk market grain can be fed liberally, but at prices usually received for butterfat or surplus milk slightly lower but more economical production occurs with grain limited to one pound per five or six pounds of milk. When grain is high in price, a smaller amount can be economically fed, but when milk products are high, the rate of grain feeding can be increased. The feeding problem of the dairyman is one of attempting to provide good grazing conditions most of the year, and then feeding grain in large amounts only when weather conditions handicap pasture growth. This means Sudan grass or soybeans for extra summer grazing, oats and rye grass for fall and winter, and enough legume or pasture hay an silage to carry through weather too cold or wet for winter grazing. (Louisiana Station Bulletin 241.)

Cottonseed Products for Milk Production: An "all Louisiana" ration of cottonseed meal, 25 parts; yellow corn or hominy, 75 parts; oyster shell flour, 2 parts; and salt, 1 part, fed with silage or pasture gave approximately as good growth and production as when soybean meal replaced the cottonseed meal, or when wheat bran, ground oats, and legume hay were included. This "all Louisiana" ration has given more economical production the past three winter tests than the test including legume hay at market prices. It is thus not necessary to feed a complicated, bulky ration when cows have silage and pasture. Under the above conditions, 330 pounds of corn and soybean silage were required to replace 100 pounds of legume hay, and it may be possible for many dairymen to produce and store 3.3 tons of silage for the cost of making one ton of high quality legume hay. Again we suggest the raising of as much hay as is practicable, depending upon some type of silo for larger dairies. **Cottonseed hulls,** fed with a high protein grain, silage, and oyster shell flour were superior to upland carpet grass hay, about equal to choice Bermuda hay, and inferior to early clover pasture hay (Louisiana Station Bulletin No. 238). Many dairy farms can produce this latter type hay to advantage in reducing costs and danger of bloat and in giving a more uniform pasture supply. Two hundred and six pounds of **whole cottonseed** were required to replace 100 pounds of **cottonseed meal** in a good dairy ration, and because of the effect on the quality of butter and production, the whole cottonseed was not satisfactory when fed with legume hay in dry lot or on pasture. (Louisiana Station Bulletin No. 227).

Shrimp Meal, fed as 10, 15, and 20 per cent of respective grain rations, satisfactorily replaced one-half of the cottonseed meal in these rations when the cows became gradually accustomed to it. Other cows, abruptly offered the shrimp meal, refused it. There was no noticeable effect on the flavor of milk or butter from cows fed shrimp meal.

Sweet Potatoes for Cows: Having in mind the small farmer with too few cows for a trench or pit silo, but raising more sweet potatoes than necessary for home use, we have recently started experiments to determine more accurately the feeding value of cull or waste potatoes. In one test, 240 pounds of sorghum silage were required, and in another 256 pounds of corn and soybean silage were necessary to equal 100 pounds chopped sweet potatoes. The average increase for the sweet potatoes over silage was 3.1 pounds of milk per cow daily. The same high protein grain was fed in both cases. For two months previous to digging, the vines were alternately grazed with an average increase of 2.6 pounds of milk per cow daily over permanent pasture, giving an average pasture value of $14.82 per acre for the vines. For the past two years light grazing at Calhoun has not seriously affected the yield of potatoes and gives promise of furnishing much needed pasture for September and October if plants are put out early.

Cost of Raising Dairy Heifers: The average dairy heifer in the University herd during the past six years consumed 888 pounds whole milk, 3167 pounds skim milk, 1059 pounds grain, 2303 pounds hay, and 2214 pounds silage before freshening. The prices of these feeds are usually so high that one is justified in raising only well-bred dairy heifers. Skim milk powder, diluted with water or fed dry, plus grain and good pasture will reduce feed costs on whole milk farms. (Louisiana Station Circular 9).

Pasture Tests: To find how valuable pasture is, feed records have been converted to pasture terms. The average value per cow of pasture at Baton Rouge was $33.47 for the past six years. The feed cost of butterfat was 13 cents per pound less on pasture than in winter. Fenced pasture plots cut monthly gave a five-year average of 10,684 pounds hay, equivalent to five and one-half tons alfalfa. Early spring pasture contained about 22 per cent protein, or twice as much as late summer grass. Cottonseed meal feeding is thus not necessary on good spring pasture but should be increased in late summer and fall.

Fertilizers for Pasture: To help produce more feed on small overstocked pastures, we have used various fertilizers at Lafayette for five years. The response to 200 pounds per acre of nitrate of soda, superphosphate, or complete fertilizer has been marked and profitable, with butterfat as low as 20 cents per pound. Nitrate plus superphosphate doubled and cyanamid plus complete fertilizer trebled the milk yield per acre over unfertilized pasture. Liming and complete fertilizing have also given profitable milk returns at Calhoun, and liming and superphosphate aided in establishing pasture at Hammond. The dairyman with poor soil or limited pasture land can increase net returns by the right use of mineral fertilizers in addition to proper utilization of manure.

Temporary Grazing Crops: Results at the North Louisiana Station show the importance of supplementing permanent pasture with grazing crops. Sudan grass has given more increase in milk and value per acre in summer grazing than permanent pasture, kudzu, cowpeas, or soybeans. Soybeans have furnished excellent grazing as well as a light hay crop for two years. Four years' results of grazing vetch and cereals indicate oats to be most valuable in winter milk production per acre, followed by rye and barley, respectively. These cereal crops have averaged 1.9 pounds more milk per cow daily than no grazing, and oats has given nearly two tons of hay per acre 60 days after removing the cows.

Mineral Deficiencies of Cattle: Many analyses of grass and forages have shown that feeds grown on all but the alluvial land and richest soils are low in lime and phosphorus. Observations confirm the opinion that cattle on these farms should be fed mineral matter to make the greatest profit, avoid losses, and check milk fever. This feed should include from one to two per cent lime (oyster shell flour is usually the cheapest form) in the grain ration of all milking cows and free choice of a mixture of two parts lime phosphate (bone char dust or bone meal are usually cheapest) and one of common salt for all cattle. On very acid land, or when no legumes are fed, it is well to add from one to two parts of lime to the latter mixture. Providing green feed or root crops will aid in utilization of these minerals and improve the food value of milk. (Louisiana Station Circular 10)

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Studies on Sugarcane Mosaic in Louisiana

By

E. C. TIMS, P. J. MILLS AND C. W. EDGERTON

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Studies on Sugarcane Mosaic in Louisiana

By

E. C. TIMS, P. J. MILLS AND C. W. EDGERTON

Since the mosaic disease of sugarcane was first recognized in Louisiana in 1919, it has been considered one of the diseases of major economic importance. By some of those interested in the sugar industry, it has been considered the most important of all the troubles affecting sugarcane, while by others it is but one of several troubles which together have been responsible for the crop failures and low yields which have occurred. In either case, it unquestionably has had considerable influence on the sugar industry of the state.

As a result of very severe crop failures which occurred simultaneously with the establishment of the mosaic disease in Louisiana, the planters were compelled to abandon certain varieties of cane and to substitute others which were more satisfactory. As time passed, some of the latter, for one reason or another, were replaced by still others. As a matter of fact, in the recovery of the sugar industry three rather definite stages can be recognized.

In the first stage, between 1926 and 1930, the industry grabbed the only canes available which might be better adapted to Louisiana. These were the Java canes, P.O.J. 36, P.O.J. 213 and P.O.J. 234. The general planting of these varieties started the recovery of the industry.

In the second stage, promising varieties from various parts of the world were obtained and thoroughly tested. Of these, the Co. 281 and Co. 290 were found to be the most satisfactory. The general planting of these in 1932 and 1933 materially increased sugar production.

In the third stage of recovery, canes selected from those produced at the United States Department of Agriculture Sugarcane Breeding Station at Canal Point, Florida, were used. Of these, the most promising seemed to be C.P. 28-11, C.P. 28-19, and C.P. 29-320. These are the canes which are receiving the most consideration at the present time.

The changes and adjustments which have been found from time to time in the Louisiana sugar industry since the introduction of the mosaic disease and the crop failures in the period between 1924 and 1926 have modified very materially the problems relating to the production of sugar. These changes have affected the problems relating to the diseases of sugarcane just as they have affected various agricultural practices. It is the object of this bulletin to review these changes as they have affected the mosaic disease, to summarize the results which have been obtained from investigational work, and to present the mosaic problem as it exists today.

The present bulletin includes information on the behavior and spread of mosaic in a number of varieties; the recovery from mosaic or the disappearance of mosaic symptons in certain varieties; the effect of mosaic on germination of buds, tonnage and sucrose content of the juice; and the results of inoculation tests in a number of cane varieties.

MOSAIC TYPES

In order to understand the results which have been obtained from the mosaic investigations in Louisiana and possibly to appreciate better the ideas to be brought out in this bulletin, it is necessary to explain briefly how the disease appears and develops on sugarcane plants.

The mosaic disease as it occurs in Louisiana appears with somewhat varying symptoms. These variations are of two kinds. *First;* there are those rather slight variations which appear on different varieties or those which are the result of environmental conditions. Slightly different symptoms may be produced when a virus from a single diseased plant is inoculated into two different varieties or when it is inoculated into plants of the same variety growing under somewhat different environmental conditions. *Second;* distinct mosaic types occur. These are characterized by symptoms which are very definite and constant. At least two such types are quite readily recognized. These are the green or mild mosaic and the yellow or severe mosaic (19, 22). The green type (Fig. 1) is characterized by slight mottling, very little yellow color in the lighter areas of the mottled leaves, very little necrosis and ordinarily very little decrease in vigor of the plants affected. The green mosaic is the type ordinarily seen on such commercial canes as the P.O.J. varieties and Co. 281.

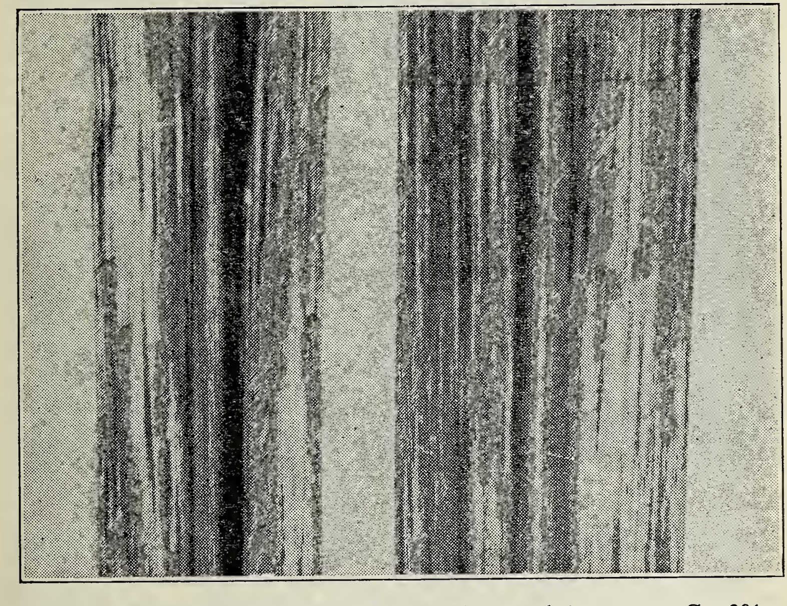

FIG. 1. Green or mild type of mosaic in leaves of the variety, Co. 281.

On the other hand, the yellow mosaic (Fig. 2) is characterized by very severe mottling. In the affected leaves, the chlorophyll is reduced to such an extent that the light colored areas appear yellow or almost white. Frequently there is a necrosis of the chlorotic areas in the leaves, and the plants are so reduced in vigor that they are decidedly stunted (Fig. 3). The yellow mosaic is more common in the recently introduced C. P. seedlings than in other cane varieties now being grown in Louisiana.

Of particular interest is the fact that both the yellow and green types of mosaic may occur in the same variety. Both types were observed in the variety C.P. 28-70 as early as 1932.

There is also evidence to support the idea that mosaics may be different or distinct even though the symptoms which occur are very similar or identical. This might be due to the presence of strains of the virus, similar perhaps to the physiologic strains which are known to occur in fungi, or if such a thing is possible, it might be due to an attenuation or modification of the virus.

The Spread of Mosaic

There are many references in the literature regarding the spread of sugarcane mosaic in different countries but the figures on the amount and rate of spread are very conflicting. In some countries, the disease unquestionably spreads rapidly, quickly becoming a menace which can not be checked except by the substitution of tolerant or resistant varieties. On the other hand, in some countries it undoubtedly spreads more slowly. The fact that mosaic has been known in the Eastern Hemisphere since 1892 and apparently did not become a factor in sugar production until it became established in the Western Hemisphere after 1910, would suggest that under certain conditions, it does not spread rapidly enough to be a menace to the sugar industry.

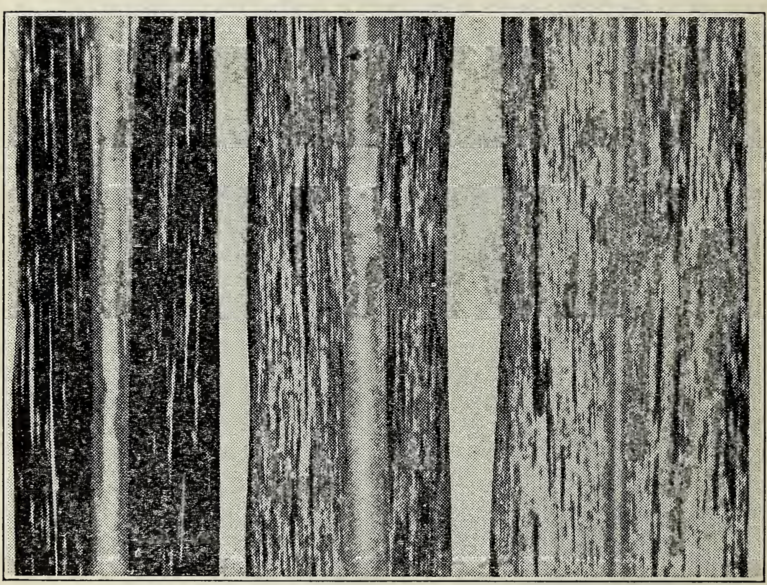

FIG. 2. Yellow or severe type of mosaic in leaves of the seedling, C.P. 28-70.

From observations and investigations carried on in recent years, it is very evident that mosaic does spread very rapidly in Louisiana in susceptible varieties when conditions are favorable. Local conditions, however, may cause great variations in the spread of the disease. As will be brought out later, the amount of mosaic has been much less in the northern and western sections of the cane belt ever since the disease first made its appearance in the state.

When first introduced, mosaic spread very rapidly in Louisiana. At the time it was reported in the state in 1919 (4), it occurred in a few localities along the Mississippi River from below New Orleans to Burtville. In 1920 (5), the disease had become established along Bayou Lafourche and in the spring of 1921 (6), it was found in the Bayou Teche area and by fall of that year, it had become rather common in that section. The disease apparently spread out in a fan-like manner over the Louisiana Sugar Belt covering it in about three year's time. This information on the original spread of the disease will be of interest when the behavior of the varieties Co. 281 and P.O.J. 213 is considered later in this bulletin.

SPREAD OF MOSAIC SINCE 1926

The Java canes, P.O.J. 36, P.O.J. 213 and P.O.J. 234, were introduced into Louisiana in about 1922 to 1923. According to some who were interested in these canes at the time, the small plantings which were growing in the state in 1924 showed practically 100% of mosaic. This condition of the cane has also been confirmed by Rands and Summers (15) who state that all three of these canes showed 100% mosaic at Southdown Plantation in Terrebonne Parish in July, 1924. Unfortunately, at the present time, there are no available records in the Louisiana Agricultural Experiment Station in regard to this point.

Since 1926, however, the available records present a very clear cut picture of the mosaic situation. In 1926, most of the cane of the P.O.J. varieties growing in the state was on Southdown Plantation in Terrebonne Parish, on the Experiment Station farm at Baton Rouge, and on the several test fields scattered throughout the sugar belt.

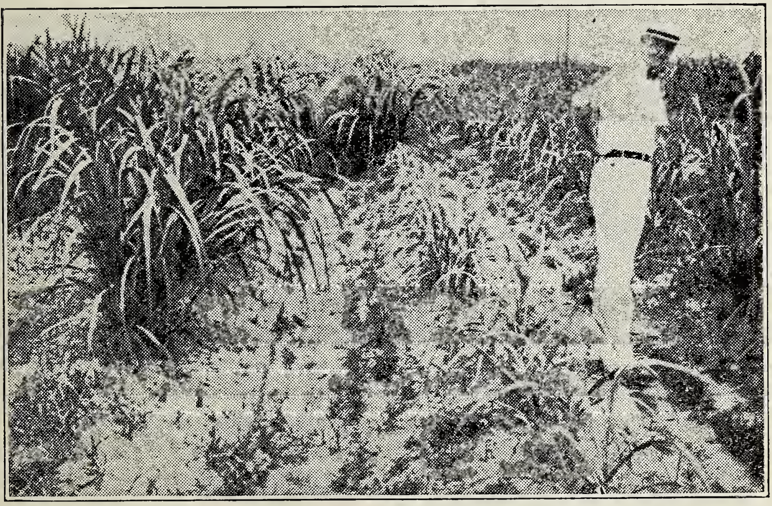

FIG. 3. Yellow type mosaic in seedling C.P. 31-449 (right center). Growth is materially retarded.

Only a trace of mosaic was noted in the P.O.J. 213 plantings at Baton Rouge in 1926. In the other two P.O.J. canes, P.O.J. 36 and P.O.J. 234, it had been quite prevalent for at least three years. At Baton Rouge, there was little change in the behavior of these varieties toward mosaic, during the succeeding five years until the summer of 1931. During this period, there was always a trace of mosaic in P.O.J. 213 though the infected plants were very few and scattered in the field. On account of the very light infection during this period, it was generally assumed that P.O.J. 213 was very resistant to the disease. This freedom from mosaic disease, as noted by Tims and Edgerton (20) seemed to be due to the ability of the variety to throw off the disease.

At other points in the Sugar Belt, practically the same condition existed during most of this period. However, in 1930, an infection of 40% was observed in one field of P.O.J. 213 at Reserve. This, at the time, was considered very unusual. Following this, a 16% infection was observed at Glenwood in Assumption Parish. At other points, the infection still remained low.

Beginning in 1931, the infection in P.O.J. 213 began to increase rapidly and the infection seemed to spread westward from the center at Reserve and Glenwood in a more or less fan-like manner similar to the spread of the original mosaic infection in the old canes.

In the meantime, the Coimbatore canes, Co. 281 and Co. 290, were introduced into the state. Co. 281 was received at Houma in 1925 and at Baton Rouge in 1928 and Co. 290 was received in 1929. On account of the superior qualities of these varieties, they were propagated very rapidly. Both of these canes were at first considered very resistant to the mosaic disease. Mosaic was first noted in Co. 281 at Erath in 1929, and later in the same year, a single infection was found at Youngsville. Both of these places are in the western part of the Sugar Belt. Appreciable infection, however, did not appear in this variety until 1931. From that time on, it increased about as rapidly in this variety as it did in P.O.J. 213. The heavy infection also seemed to have originated in the eastern section though this was not as noticeable as in P.O.J. 213, perhaps due to the fact that seed cane of Co. 281 was shipped all over the state and undoubtedly the infection was carried with it.

In Co. 290, mosaic was first observed at Reserve in 1930. Since then, it has increased rather slowly with a more rapid increase in the eastern section of the Sugar Belt. The increase in the western section occurred later as it did in the variety of P.O.J. 213.

The increase in mosaic in the varieties P.O.J. 213, Co. 281, and Co. 290 at the different test fields from 1929 to 1932, is given in table 1. The figures are not quite comparable to the general condition around the state because the seed cane used was obtained from different localities. However, these figures give in a general way, the main facts regarding the spread of mosaic during that period.

The rapid rise in the mosaic percentage in the years following 1930 is brought out in the table. The low percentage of mosaic in the test field at Cinclare was undoubtedly due to the fact that seed cane was sent there from Baton Rouge before the mosaic began to increase rapidly at Baton Rouge. A pickup in the mosaic infection has occurred at that place since 1932.

No exact records have been kept of the mosaic infection since 1932 but estimates were made in various fields in 1934. In that year, in the variety P.O.J. 213, there was nearly 100% at Reserve and Glenwood, from 50 to 60% at Sterling, somewhat less at Cinclare and Youngsville, and from 10 to 15% infection at Meeker. In Co. 281, mosaic infection was very general (70 to 90%) over most of the southern portion of the cane belt, but in the extreme northern part in the vicinity of Bunkie and Meeker, it was still comparatively light. For Co. 290, accurate data are not available but infection percentages as high as 70% were noted at Reserve, 30 to

40% at Glenwood, 5 to 10% at Cinclare, Sterling, and Youngsville, and only a trace at Meeker.

That the mosaic disease is capable of spreading rapidly in the varieties Co. 281 and P.O.J. 213 has also been shown by field tests. Plots were planted at Reserve and Baton Rouge in 1932 and 1933 with mosaic-free cane of these varieties. Some mosaic showed up in these plots when the first counts were made in the spring, indicating either very early spread in the field or some masking of symptoms at the time the seed cane was cut for planting. The average percentages of mosaic-infected stalks in these plots at different times during the growing season are given in table 2.

TABLE 1. Percentage of mosaic infection in P.O.J. 213, Co. 290 and Co. 281 (plant cane) at the different test fields from 1929 to 1932.

Year	Reserve	Cinclare	Glenwood	Sterling	Meeker	Youngsville
P. O. J. 213						
1929	trace	trace	7.8	0.6	0.0	0.2
1930	25.0	1.4	16.0	3.0	trace	8.0
1931	45.0	3.0	20.0	6.3	3.2	12.6
1932	78.0	1.7	86.0	52.0	....	47.0
Co. 290						
1930	trace	0.0	0.0	0.0	0.0	0.0
1931	4.0	0.0	trace	trace	0.0	0.0
1932	7.4	trace	6.2	3.6	trace	trace
1933	24.0	trace	6.7	4.6	trace	trace
Co. 281						
1929	0.0	0.0	0.0	0.0		trace
1930	2.6	trace	10.6	6.1	trace	1.8
1931	31.0	1.0	44.0	40.0	2.0	26.0
1932	64.6	8.0	59.0	40.6	7.3	62.0

The disease spread very rapidly at Reserve during both seasons. Observations made late in the season of 1934 (September) showed only a very few healthy

TABLE 2. Increase of mosaic in plots planted with healthy seed cane at Baton Rouge and Reserve.

Variety	BATON ROUGE					RESERVE			
	% Mosaic-infected Stalks					% Mosaic-infected Stalks			
	1933		1934			1933		1934	
	June 16	Sept. 9	May 26	July 6	Sept. 27	May 25	Aug. 20	May 22	July 12
Co. 281........	4.0	45.7	2.3	10.0	42.0	3.2	71.4	5.5	47.0
P. O. J. 213.....	11.0	57.4	4.0	18.0	74.2	4.6	84.7	7.0	77.4

stalks in the entire series of plots at Reserve. The mosaic spread more slowly at Baton Rouge than at Reserve, though considerably more than half the stalks of P.O.J. 213 had mosaic at the end of the season.

Why such varieties as P.O.J. 213 and Co. 281 apparently showed a high degree of resistance to the mosaic disease for at least seven years, from 1923-1930, and then suddenly became very susceptible has not as yet been definitely explained. It must be remembered that the fields of these varieties were entirely surrounded by fields of the old canes that showed a maximum of infection. Several theories have been advanced to explain this condition but most of these apparently are not tenable. The theory advanced by Tims and Edgerton (21) in 1932 that there is possibly more than one strain of sugar cane mosaic in the state is perhaps the most reasonable. It may be that a new strain of mosaic, one which is possibly more virulent or to which these varieties shows less resistance, became established in the Reserve district in about 1930. If this were the case, it would be a simple matter to explain the spread of the disease in these varieties. More evidence supporting this theory will be presented later in this bulletin.

Susceptibility of the Newer Cane Varieties

Artificial inoculation tests made over a period of three years have proven that Co. 281 and P.O.J. 213 are very susceptible to mosaic at the present time. The results obtained corroborate the observations which have been made throughout the state, during a period of several years. A high percentage of infection and a moderately short period of incubation have been obtained in the inoculation tests with Co. 281 and P.O.J. 213, both of which indicate high susceptibility.

The variety, Co. 290, which was introduced into the state a year later than Co. 281, has reacted somewhat differently towards mosaic. For two years following the first recorded infection in 1930, the disease spread rather slowly though a more rapid spread has been observed in recent years. It is much more resistant to artificial inoculation with the mosaic virus than either Co. 281 or P.O.J. 213. Also infected plants will occasionally throw off or recover from the disease.

The variety, C.P. 807, a second generation seedling of P.O.J. 213, was brought into Louisiana in 1926 and was released for general planting in the fall of 1930. This variety remained practically free of mosaic for several years. A single infected stool was reported in Terrebonne Parish in 1932 but there was very little spread of the disease until 1934. In that year, scattered stools of mosaic-infected cane in fields which were supposed to be pure stands of C.P. 807 were observed in the extreme southern part of the state. None of the disease was seen in other parts of the state.

In the more recently introduced Canal Point seedlings, the mosaic behavior has not been studied over as long a period of years, but the records are worth noting at this time. C.P. 28-11, introduced in 1930, apparently remained free of mosaic until 1934. In that year, scattered stools of this variety infected with the yellow type of mosaic were observed throughout the Sugar Belt. In C.P. 28-19, which was also introduced in 1930, the yellow type of mosaic was observed at Baton Rouge in 1932. C.P. 29-320 was introduced in 1931 and apparently remained free of mosaic until 1933. In that year, the green type of the disease appeared and thereafter spread rather freely. In none of these varieties, however, has the spread of the disease been rapid. A careful survey of the state was made in May, 1934, and the relative amount of the disease in these varieties was determined. This information is given in table 3.

Observations were also made later in the summer at Baton Rouge, Reserve and Glenwood. At that time, mosaic symptoms had disappeared from a large percentage of the stalks of C.P. 28-11 which showed the disease very clearly in May. Only 26 of 94 stalks that showed mosaic at Reserve in May, 1934 had definite symptoms of the disease in July. These plants were tagged and examined again the latter part of August. At that time, 17 of the original 94 stalks showed very faint mosaic symptoms in the very oldest leaves and none in the young leaves. A number of these stalks were planted at Baton Rouge in late August. When the young shoots coming from these stalks were examined late in the fall of 1934, only 3 out of 23 of them showed mosaic. A number of mosaic inoculation tests made during the late spring and summer of 1934 in C.P. 28-11 all gave negative results.

The behavior of mosaic in C.P. 28-19 has been somewhat different from that in C.P. 28-11, although both varieties showed about the same amount of infection during the early summer of 1934. Mosaic has spread very slowly in this variety, only a few scattered infections having been noted in the various plantings over the cane belt. The mosaic symptoms apparently do not disappear from C.P. 28-19 as readily as they do from C.P. 28-11. In one series of artificial inoculations made in the summer of 1933, a high percentage of infection was obtained, but in late October the mosaic symptoms had disappeared from most of these stalks (10 out of 14). When several of the inoculated stalks were planted, the shoots from some of them showed mosaic, although the stalks of stubble cane coming up after they were cut, with the exception of one stool, remained free of the disease. This indicates that the mosaic virus did not reach the bottom of the stalks before they were cut for planting. Later inoculation experiments with this variety have not been successful.

TABLE 3. Mosaic conditions in C.P. 28-11, C.P. 28-19, and C.P. 29-320 in test fields at different points in the cane belt. Observations made May 22-30. 1934.

TEST FIELD	C. P. 28-11		C. P. 28-19		C. P. 29-320	
	Number Acres Examined	Number Infected Stools	Number Acres Examined	Number Infected Stools	Number Acres Examined	Number Infected Stools
Glenwood	4	19	5	15	1/3	9
Reserve	4	25	2	5	3/7	19
Sterling	2	16	3	15	1/3	46
Cinclare	2	0	2	0	4/7	10
Meeker	4/7	0	1	0	1/10	0
Youngsville	1/14	0	1/14	0	1/14	0
Billeaud	4	0	1	0	1/3	0
Iberia Livestock Farm	1/6	1	1/4	1	1/12	0
Baton Rouge	1	6	2	4	1	104

The variety C.P. 29-320 appears to be one of the most promising varieties released in the state in several years. The mosaic disease spreads rather rapidly in this variety, but as will be brought out later in this bulletin, a very large percentage of the plants apparently recover from the disease. It will also be shown that infection is not readily produced by artificial inoculation.

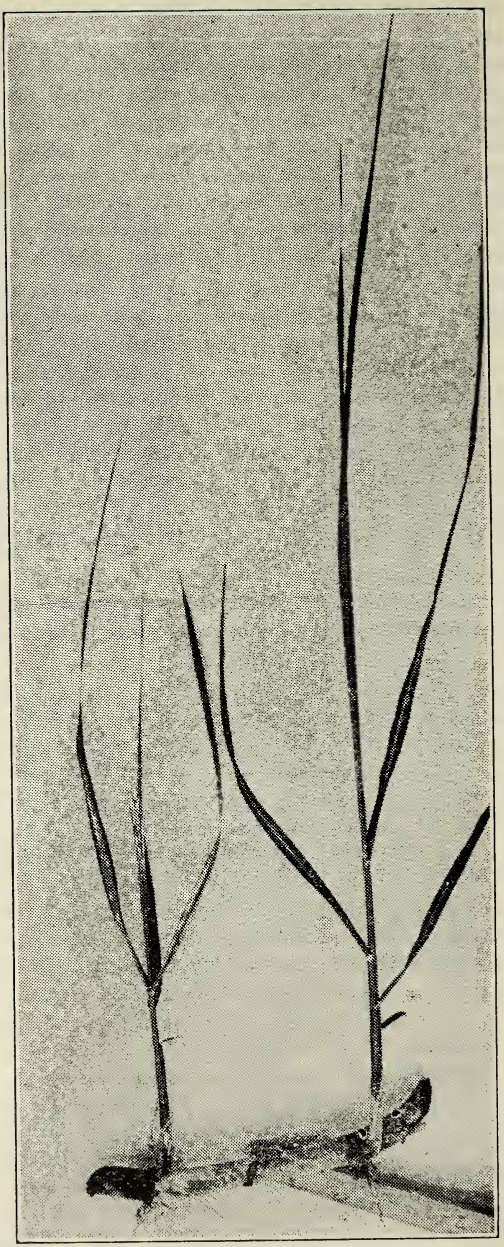

FIG. 4. Mosaic-infected shoot (left) and mosaic-free shoot (right) growing from same seed stalk of C.P. 28-70.

Recovery from Mosaic

The apparent recovery of sugarcane affected with the mosaic disease has been noted by several workers. Kunkel (8) in 1924, working with varieties of the Noble type in Hawaii, found considerable variation in the ability of the different ones to recover from mosaic. He found that D. 1135 showed a remarkable ability to recover; H. 109, Badila, Lahaina, and Yellow Caledonia showed some tendency to recover, but with D. 117, not a single case of recovery was observed. Apparent recovery of Crystalina cane was reported by East and Weston (3) in Cuba in 1925. In 1929, Stahl and Faris (18) reported studies on mosaic behavior in the varieties P.O.J. 2714, P.O.J. 2725 and P.O.J. 2727. These men working in Cuba found that some healthy shoots invariably developed from mosaic infected stalks. In 1931, Tims and Edgerton (20) reported four years' studies on mosaic behavior in several of the P.O.J. varieties, including P.O.J. 36, P.O.J. 213, P.O.J. 228 and P.O.J. 234. They found that over a period of four years, mosaic symptoms disappeared during the growing season from some stalks of all four varieties but this was more pronounced with P.O.J. 213 and P.O.J. 228. It was also observed that many healthy shoots developed from mosaic infected stalks when the latter were planted. In 1932, Rands and Summers (15) reported studies on the disappearance of mosaic symptoms from certain cane varieties in Louisiana. Their results were somewhat similar to those of Tims and Edgerton.

Studies on the recovery of sugarcane plants from the mosaic disease and the associated disappearance of the symptoms of the disease have been in progress at The Louisiana Agricultural Experiment Station for a number of years. Since 1926, these studies have been largely confined to the P.O.J. and other recently introduced varieties. A portion of the results which have been obtained have already been published. However, as a knowledge of this part of the work is essential for an understanding of the later investigation, some of the results will be included in this bulletin. It is also necessary to consider the earlier results, those obtained between 1926 and 1930, distinct from those which have been obtained since. The reasons for this will be evident as the experimental work is discussed.

Recovery from Mosaic—1926-1930

Carefully planned tests to determine whether mosaic symptoms would disappear from infected stalks were started in 1926. In October of that year, twenty-five stalks of each of the varieties P.O.J. 213 and P.O.J. 228, which showed typical mosaic symptoms, were cut and planted. During the following year, the plants developing from these stalks were watched. Both varieties showed a fairly high percentage of mosaic during the summer, but during the fall, there was a material decrease. In October, as shown in table 4, only six plants out of 366 of the variety P.O.J. 213 showed mosaic symptoms and 71 out of 221 plants of P.O.J. 228.

TABLE 4. Mosaic stalks developing from infected seed cane—1927.

VARIETY	May 7, 1927		August 15, 1927		October 19, 1927	
	Mosaic	Healthy	Mosaic	Healthy	Mosaic	Healthy
P. O. J. 213	28	54	177	136	6	360
P. O. J. 228	16	20	101	77	71	150

In the fall of 1927, the six mosaic stalks of P.O.J. 213 and a larger number of the infected stalks of P.O.J. 228 were planted and the progeny watched during the season of 1928. At the same time, a number of disease-free stalks from the same plat were planted. From the disease-free stalks, no mosaic plants developed. The results obtained from the diseased stalks are given in table 5. Again a considerable percentage of the plants developing from mosaic stalks were free of the disease.

TABLE 5. Mosaic stalks developing from infected seed cane—1928.

VARIETY	June 4, 1928		July 28, 1928		September 25, 1928	
	Mosaic	Healthy	Mosaic	Healthy	Mosaic	Healthy
P. O. J. 213	21	21	51	89	20	117
P. O. J. 228	170	214	287	412	326	372

In the fall of 1928, plats were planted with mosaic-infected cane of the varieties P.O.J. 36, P.O.J. 36-M, P.O.J. 234, P.O.J. 213, P.O.J. 228, and Louisiana Striped. Mosaic counts made the following spring showed that some mosaic-free shoots were produced from mosaic-infected stalks of all the varieties included in the test. The results of the first two counts are given in table 6.

TABLE 6. Mosaic stalks developing from infected seed cane—1929.

VARIETY	May 8, 1929		July 10, 1929		Percentage of Healthy Shoots
	Mosaic	Healthy	Mosaic	Healthy	
P. O. J. 36	202	149	1365	275	16.0
P. O. J. 36-M	515	541	2467	1954	44.0
P. O. J. 234	648	542	2083	2433	53.0
P. O. J. 213	38*	39	138	238	63.0
P. O. J. 228	60*	56	150	368	72.0
La. Striped	532	134	3400	183	5.0

* Small plots of about 75 running feet planted with these two varieties.

Recovery was observed in all the varieties tested in 1929 and it was found to be particularly high in P.O.J. 213 and P.O.J. 228. These results are similar to those reported for the two preceding years.

During the summer of 1929, stalks of several varieties which showed typical mosaic symptoms were selected and marked with permanent tags. At planting time, the stalks were examined for mosaic symptoms before being cut. The tagged stalks were planted separately in such a way that individual records could be kept of the mosaic condition in the shoots which developed the following year. The results of the test are included in table 7. Mosaic symptoms disappeared from a number of stalks of P.O.J. 36, P.O.J. 228, and P.O.J. 213 during the growing season, and many stalks of P.O.J. 213 and P.O.J. 228, which showed mosaic at planting time, produced only healthy shoots.

The tests which were conducted between 1926 and 1930 show very conclusively that during that period mosaic symptoms disappeared very rapidly from several of

TABLE 7. Mosaic condition at planting time of stalks which showed mosaic symptoms in June, 1929. Also disease condition of shoots developing from these stalks as shown by observations made on May 22, 1930.

VARIETY	NUMBER OF STALKS				
	Showing Mosaic at Planting Time	Showing No Mosaic at Planting Time	Producing Some Mosaic Shoots	Producing Only Healthy Shoots	Producing Both Healthy and Mosaic Shoots
P. O. J. 36...........	37	13	49	1	20
P. O. J. 213..........	34	13	27	20	17
P. O. J. 228..........	43	5	15	24	6
P. O. J. 234..........	41	5	43	2	4
L. 511..............	42	0	15	6	0

the common varieties and that the cane plants apparently recovered from the disease. This disappearance of symptoms was very marked in the varieties P.O.J. 213 and P.O.J. 228. Also when planted, a very large part of the stalks from which the mosaic symptoms disappeared produced perfectly healthy shoots. It seems evident that the low percentage of mosaic that showed on these varieties throughout the state previously to 1930 was due very largely to the high percentage of recovery from the disease.

Recovery from Mosaic—1930-1934

The investigations which have been conducted on the disappearance of mosaic symptoms since 1930 have given somewhat different resutls from those obtained previously to that date. A new factor, which was responsible for this condition, had evidently become involved in this phase of the mosaic problem.

As has been brought out on a previous page, the mosaic percentage began to increase rapidly in certain varieties, particularly P.O.J. 213 and Co. 281, in 1930. Rather suddenly the mosaic picture throughout the sugar belt of Louisiana became entirely different from what it had been. The explanation of this was not clear but there was a possibility that the cane plants were not throwing off the symptoms and recovering from the disease as they had been during the preceding years. Consequently, it seemed important to modify the tests which were being run to confirm this possibility.

As the mosaic did not seem to be increasing at the same rate in all sections of the state, it seemed advisable to check the recovery from the disease in cane plants from different sections. The rapid increase in the spread of the mosaic disease was first observed at Reserve and later at Glenwood. At Baton Rouge, on the other hand, where the tests on recovery had been conducted, the natural increase in the mosaic percentage occurred somewhat later. It was decided to check the disappearance of mosaic symptoms using cane from localities where the mosaic behavior seemed to be different.

In the fall of 1930, infected stalks of the different varieties were again planted at Baton Rouge. In addition to using seed cane grown at Baton Rouge, mosaic infected stalks of Co. 281 and P.O.J. 213 were brought to the Experiment Station from Reserve. The results obtained are given in table 8.

The difference in behavior of mosaic in P.O.J. 213 from Reserve and from Baton Rouge is evident. The P.O.J. 213 from Baton Rouge continued to throw off the disease, while that from Reserve did not to any appreciable extent. It will also be noted that Co. 281 from Reserve did not throw off the disease.

TABLE 8. Results obtained with mosaic-infected stalks planted at Baton Rouge in 1930. All the stalks showed mosaic symptoms at time of planting. Ob-

Variety	Source	Stalks Planted	Stalks Germinated	Stalks Producing Only Mosaic Shoots	Stalks Producing Healthy and Mosaic Shoots	Stalks Producing Only Healthy Shoots
P. O. J. 213...	Baton Rouge....	43	37	9	21	7
P. O. J. 213...	Reserve.........	18	12	11	1*	0
Co. 281......	Reserve.........	65	64	63	0	1
P. O. J. 228...	Baton Rouge....	45	43	15	22	6
P. O. J. 36....	Baton Rouge....	48	48	42	6	0
P. O. J. 234...	Baton Rouge....	45	45	10	27	8

* Only one healthy shoot developed.

In 1931 plots were again planted at Baton Rouge and mosaic infected seed cane of the varieties P.O.J. 213, Co. 281 and Co. 290 were brought from Reserve and Glenwood. The 1932 data are given in table 9.

TABLE 9. Results obtained with mosaic infected stalks planted at Baton Rouge in the fall of 1931. Observations made in July, 1932.

Variety	Source	NUMBER OF STALKS				
		Planted	Germinated	Producing		
				Only Healthy Shoots	Only Mosaic Shoots	Both Healthy and Mosaic Shoots
P. O. J. 213...	Glenwood.......	25	25	1	24	0
	Reserve.........	87	77	1	76	0
	Baton Rouge....	50	50	20	22	8
Co. 281......	Glenwood.......	25	25	0	25	0
	Reserve.........	83	83	0	79	4
Co. 290......	Glenwood.......	26	26	1	21	4
	Reserve.........	77	77	2	69	6
P. O. J. 228...	Baton Rouge....	50	49	11	29	9
P. O. J. 36....	Baton Rouge....	50	50	7	30	13
P. O. J. 234...	Baton Rouge....	50	50	0	40	10

It will be observed that mosaic-infected stalks of P.O.J. 213 from Baton Rouge continued to throw off healthy shoots, while similar cane from Reserve and Glenwood produced shoots which were practically all affected with mosaic. The P.O.J. 213 and P.O.J. 228 from Baton Rouge showed the highest degree of recovery in this set of plantings, agreeing with results obtained previously to 1930. The Co. 290 produced a small percentage of disease-free shoots.

In 1932, the planting of mosaic-infected stalks was continued. This time stalks of plant and first year stubble cane of each variety were planted, to determine whether mosaic would disappear from the stubble cane as it did from plant cane. The results are given in table 10.

TABLE 10. Results obtained from planting mosaic-infected stalks of stubble and plant cane. All the stalks showed mosaic symptoms when planted in October, 1932. Observations made in July, 1933.

Variety		Source	Stalks Planted	Stalks Germinated	STALKS PRODUCING		
					Only Mosaic Shoots	Healthy and Mosaic Shoots	Only Healthy Shoots
P. O. J. 213	Plant	Reserve	50	49	49	0	0
	1st Stubble	Reserve	58	50	50	0	0
	Plant	Baton Rouge	47	45	40	3	2
	1st Stubble	Baton Rouge	50	50	35	14	1
Co. 290	Plant	Glenwood	48	48	47	1	0
	1st Stubble	Glenwood	25	25	24	0	1
P. O. J. 228	Plant	Baton Rouge	49	41	37	1	3
	1st Stubble	Baton Rouge	50	49	44	4	1
P. O. J. 36-M	1st Stubble	Baton Rouge	50	50	47	3	0
P. O. J. 234	1st Stubble	Baton Rouge	50	50	48	2	0
Co. 281	Plant	Reserve	48	48	48	0	0
	1st Stubble	Reserve	50	50	50	0	0

The results of the 1933 test show that healthy shoots developed from a few stalks of infected cane from Baton Rouge but practically none from similar cane from Glenwood and Reserve. The recovery, however, was not as pronounced in the Baton Rouge cane as it had been in previous years. This was hardly to be expected as, by this time, mosaic was spreading rapidly in P.O.J. 213 and Co. 281 in the field. Recovery occurred with both plant and stubble cane.

In the fall of 1933, a smaller test was started. Plots were planted with the following varieties, fifty stalks of each being used: Co. 290, Co. 281, P.O.J. 228, P.O.J. 213 (Reserve type), and P.O.J. 213 (Baton Rouge type). When examined in June, 1934, it was found that four stalks of Co. 290 had produced both healthy and mosaic shoots, three stalks of P.O.J. 228 had produced some healthy shoots, while all the shoots from Co. 281 and P.O.J. 213 were infected with mosaic. It is seen that by 1934, all the cane of P.O.J. 213 and Co. 281, whether obtained from Baton Rouge, Reserve, or Glenwood was behaving in a similar manner. Mosaic symptoms were not disappearing and the recovery from the disease was at the most very slight.

While several explanations might be offered to account for the peculiar behavior exhibited by P.O.J. 213 and some other varieties towards mosaic during the period in which these investigations were in progress, the most likely one seems to rest on the existance of more than one strain of the mosaic virus. All the results which have been presented can be explained very readily by assuming that a new strain or a more virulent strain of the mosaic virus became established in the river district, possibly around Reserve, in about 1929 or 1930. This would explain why P.O.J. 213 became more susceptible and finally ceased to throw off the disease and also would explain why Co. 281 apparently seemed to become very susceptible after remaining free of the disease for several years. There is no known reason why different virus strains cannot occur or may not develop in nature just as they do occur with fungi and bacteria. The evidence seems to prove that it is a fact.

BEHAVIOR OF C.P. 29-320

The present behavior of the new variety C.P. 29-320 is very interesting when it is compared with that of P.O.J. 213. This variety is acting more or less like P.O.J. 213 did during the first few years after its introduction. It was introduced in 1931 and the green type of mosaic was first observed on it in the summer of 1933 at Baton Rouge. After the disease was first observed, it was watched very closely.

The plot of C.P. 29-320 at Baton Rouge in 1933 consisted of fourteen rows about 400 feet in length. Beginning on May 23, a complete record was kept of the mosaic developing in this area. The number of locations where mosaic infection was observed and the total number of infected stalks on different dates during the summer are given in table 11.

TABLE 11. Records of mosaic development in 14 rows of C.P. 29-320 plant cane during the growing season of 1933.

Date	Number of New Mosaic Locations	Number of Newly Infected Stalks	Total Number of Mosaic Locations	Total Number of Mosaic Infected Stalks
5/22/33	0	0	0	0
6/ 9/33	17	49	17	49
6/24/33	21	48	38	97
7/10/33	9	24	47	121
7/27/33	6	7	53	128
8/12/33	0	0	..	...
8/31/33	0	0	..	...
9/22/33				64

The maximum number of infected stalks was noted on July 27. Observations made later in August showed no new infections. On September 22, only 64 of the original mosaic-infected stalks showed symptoms of the disease. This indicated a rather rapid disappearing of the mosaic symptoms during the latter part of the summer.

During the following year, 1934, records were kept on the first year stubble in the same plot of C.P. 29-320. The first observations made on May 1 showed mosaic infection at 34 locations, with a total of 103 infected stalks. On June 15, there were 136 locations with 362 diseased stalks. On August 14, the number of mosaic locations had fallen off to 77 and the infected stalks to 276. Due to the height of the cane and the difficulty experienced in examining it without excessive breakage, no later observations were made until planting time in early October. At that time only 45 stalks showing mosaic symptoms could be found.

In order to obtain more definite data on the disappearing of mosaic in C.P. 29-320, 100 stalks showing the disease were tagged at random in the same plot of 14 rows of first year stubble cane on June 22, 1934. The tagged plants were examined at weekly intervals for 12 weeks. The mosaic symptoms began to disappear within one week after the stalks were tagged. By the eighth week, the disease had disappeared from 18 plants, and at the end of the twelfth week, mosaic symptoms had disappeared from the entire 100 stalks. Another set of 90 mosaic-infected stalks was tagged on July 2. When examined on August 14, 30% of these tagged plants showed no mosaic symptoms.

A planting test with C.P. 29-320 was also made in the fall of 1933. Mosaic-infected stalks were planted in three 50-foot sections of row. When the first shoot counts were made May 26, 1934, an average of 35% of the shoots showed mosaic symptoms, but on October 23, only 7.3% of the stalks showed the disease. Inoculation tests made with juice from the stalks which had apparently recovered from mosaic showed that some of these plants, though not all of them, had the active mosaic principle left in them after the visible symptoms had disappeared from the leaves.

The data at present available, based on two years' investigations, show that the variety C.P. 29-320 will take the mosaic disease and in the spring, a small percentage of infection will be observed in the field (not over 1% has as yet been observed), but during the summer the mosaic symptoms very largely disappear from the infected plants.

It is impossible to predict just how mosaic will continue to develop in C.P. 29-320; at present, the disease is causing no perceptible damage to the cane. But after a period of years, will it become more susceptible as has been the case with P.O.J. 213?

Effect of Mosaic on Germination of Buds

The statements in the literature in regard to the effect of mosaic on the germination of sugarcane buds are somewhat conflicting. Unfortunately many of these are based on observation alone and are not entirely convincing. Considering those based on carefully conducted tests, it is evident that under some conditions, the vitality of the cane may be reduced to such an extent by the disease that the germination of the buds is affected to a greater or less extent. Under good growing conditions, however, this is ordinarily not the case and as good, or practically as good, germination can be expected from mosaic-infected cane as from healthy cane.

In Louisiana, information on the effect of the mosaic disease on germination of the buds has been accumulating for a number of years.

In the period between 1921 and 1928, when the old Noble canes, Louisiana Purple and D. 74, were still being planted, strains of these were obtained by selection which did not show marked symptoms of mosaic. In the plots planted with the selected strains, in comparison with field-run unselected cane, the germination of the selected strains was almost invariably better. However, these results are not convincing as other factors associated with the selection of seed cane undoubtedly had considerable influence.

Between 1929 and 1931, plots were planted with mosaic-infected and healthy seed cane of the varieties, P.O.J. 36, P.O.J. 213 and P.O.J. 234. Stand counts were made in the spring of each year. While the percentage of germination was not obtained because counts were not made of the actual number of buds planted, no consistent or apparent differences were noted in the stands of cane in the plots planted with mosaic and mosaic-free seed cane.

In 1932 and 1933, similar plots were planted with diseased and healthy seed cane but a count was made of the good, sound buds before the cane was planted. In the spring, the number of shoots developing from these buds was obtained as accurately as possible. This information is not easy to obtain and sometimes almost impossible. The young shoots often begin to produce suckers early and it is not always possible to distinguish between original shoots and suckers. The observations made in 1933 and 1934 in plats at Reserve and Baton Rouge are given in table 12.

TABLE 12. The effect of mosaic on germination of buds. The buds were counted when planted and the number of shoots obtained in the spring.

Variety	PERCENTAGE OF GERMINATION							
	April 3-5, 1933				April 24-25, 1934			
	Reserve		Baton Rogue		Reserve		Baton Rouge	
	Mosaic	Healthy	Mosaic	Healthy	Mosaic	Healthy	Mosaic	Healthy
P. O. J. 213	25.3	26.2	27.6	27.6	19.6	21.2	33.4	38.9
Co. 281	25.0	27.1	39.2	39.1	17.0	17.2*	34.8	37.8
P. O. J. 234	....	....	35.2	42.9	....	....	....	....
Co. 290	....	....	....	....	27.5	29.2	71.4†	62.9†
C. P. 28-70‡	....	....	33.5	40.7	....	....	35.1	44.2

* Co. 281 germinated more slowly than the other varieties and probably a later count would have shown a higher germination.

† In 1934 at Baton Rouge, stand counts were made and the results include both original shoots and suckers.

‡ Yellow type mosaic in C.P. 28-70.

The variety, Co. 290, suckered so early at Baton Rouge in 1934 that it was not possible to obtain other than a stand count. On all the other plats, the actual percentage of original shoots developing from seed stalk eyes, or in other words, the actual percentage of germination was obtained.

The figures as given in table 12 indicate that with most of the varieties, the mosaic disease only caused a slight reduction in germination of the buds. It should be noted, however, that there was a marked reduction in germination of C.P. 28-70 which was affected with the yellow type of the disease.

In addition to the field tests, two germination tests were made in the greenhouse under more or less ideal conditions. The mosaic and healthy stalks of cane were selected in the field, and cut into pieces each containing a single, sound bud. Each lot contained 500 seedpieces. These were planted during late summer or early fall when conditions were favorable for rapid germination in a greenhouse bench containing sterilized field soil. The results of the two tests are given in table 13.

TABLE 13. Results of germination tests with healthy and mosaic-infected seed cane under greenhouse conditions. Each lot consisted of 500 buds. Test 1. August 25-September 25, 1933. Test 2. Fall of 1934.

Variety	PERCENTAGE GERMINATION			
	Test 1		Test 2	
	Mosaic	Healthy	Mosaic	Healthy
Co. 281	89	84	89	94
Co. 290	..	..	80	76
C. P. 28-70	..	..	88*	80
P. O. J. 213	83	80	..	..

* Yellow type mosaic.

Under greenhouse conditions during warm weather and with sterilized soil, it is apparent that the mosaic disease did not influence the germination of the buds.

From tests and observations made over a period of several years, some rather general statements can be made in regard to reductions in germination of buds and to suckering of certain verieties. As far as observed, mosaic has not caused an appreciable reduction in stand of P.O.J. 234 or P.O.J. 36. Some rather slight increases in stands have been noted in plots planted with mosaic-free P.O.J. 213, but these differences have not been entirely consistent. The tests with Co. 290 have not been carried on long enough to get an entirely clear picture of the effect of the mosaic disease on germination, but there is no indication of reduced germination at present. On the other hand, based on two years' results, the yellow type of mosaic does seem to cause a reduction in germination of the buds of C.P. 28-70 though differences in the final stands in the field are not as great as the differences in germination might indicate.

Effect of Mosaic on Yields and Sucrose Content

The effect of mosaic on the yield of cane and the sucrose content of the juice has been discussed by many investigators in various parts of the sugar world. While it is undoubtedly true that many of the conclusions are based on observations alone or upon insufficient data and consequently may not be very accurate, still there is sufficient data to indicate that the effect of the disease may vary to a very considerable extent in different countries or under different conditions. It is apparent that the losses from mosaic vary with the varieties used and the conditions under which the cane is grown. It also seems probable that different strains of the mosaic may occur and this may account for some of the variations with some varieties.

No attempt will be made to cover the literature on the effect of the mosaic disease on the yields of cane. It may be interesting, however, to note some of the extremes which have been presented by different workers.

In Puerto Rico, Chardon (2) claims that the losses have been very heavy and notes some as high as 60%. In Cuba, Bruner (1) reported a reduction in yield of Crystalina cane of 62%. He stated that the healthy stalks of this variety averaged more than twice as heavy as those affected with mosaic. In the Philippines, Lee (9) reported losses varying from 21.5 to 69.3% in the different varieties planted.

In contrast to these reports, McRae and Subramanian (11, 12, 13, 14) reported an average loss of only 8.2% in the variety Co. 213 in Pusa, India. They conducted tests during a period of four years. The only factor that varied consistently in favor of the healthy plots in their tests was the calculated juice from the cane. The decreases in quantity of juice from mosaic cane were 4.8, 15.4, 4.0 and 13.8% respectively for the four years.

From the literature, it is apparent that the losses caused by mosaic may vary from very slight reductions in yield to losses as high as 40 to 60%. As to the sucrose content of the juice, most investigators claim that the reduction is negligible or at least very slight.

In Louisiana, data on the effect of the mosaic disease on tonnage and sucrose have been accumulating over a period of years. Data are available on the old Noble varieties as well as on the P.O.J. and other varieties which have been planted in recent years.

The tests with the Noble varieties were conducted for the most part in the period between 1922 and 1931. These were of two types.

1. Tests were made with the varieties, Louisiana Striped and L. 511, using mosaic-infected and mosaic-free seed cane.

2. Tests were also conducted with selected strains of the varieties, Louisiana Purple and D. 74. These strains (7) were obtained by selecting plants that were growing vigorously and also which showed the disease in a very mild form. Plants that were free of the disease were not selected. The object of the selection work was to determine if resistant or tolerant strains within a variety could be obtained by selection.

The results obtained in the yield tests with the Noble varieties during this period are summarized in table 14.

In these tests, very noticeable and consistent increases in yield were obtained with the selected strains of D. 74 and Louisiana Purple. It would not be fair, however, to claim that the mosaic factor was entirely responsible for these results. Carefully selected seed cane would undoubtedly have given somewhat better yields even if no mosaic was present. The decreases in yields obtained in the tests with Striped cane were rather moderate.

After their introduction into the state, the P.O.J. varieties, P.O.J. 36, P.O.J. 36-M, P.O.J. 213, and P.O.J. 234, were included in the yield tests, as they were all known to be susceptible to the mosaic disease. P.O.J. 36, P.O.J. 36-M, and P.O.J. 234 showed a high percentage of infection when they were first distributed for general planting in Louisiana, but there was no information available as to how seriously they were affected. It was generally claimed that they were more or less tolerant to the mosaic and would not be seriously injured even though the percentages of infection were very high.

In 1928, replicated plots were planted with healthy and mosaic-infected seed cane of P.O.J. 36, P.O.J. 36-M, and P.O.J. 234 varieties. Similar tests were conducted in 1930 and 1931 with P.O.J. 36-M. In these tests, P.O.J. 213 was not included because at that time this variety appeared to be resistant and sufficient infected seed cane could not be obtained. The results as summarized in table 15 indicate only moderate losses from mosaic in these tests. The spread of mosaic to the healthy plots was rather general, and the recovery of many plants from mosaic in the diseased plots was noted. Both of these factors were possibly concerned in the final results.

TABLE 14. Reduction in yield of plant cane of the old varieties due to mosaic. Effect of mosaic on Striped and L. 511 varieties and on strains of Louisiana Purple and D. 74 selected for resistance to the disease.

Year	Location	Variety	Percent Reduction Due to Mosaic
1922	New Orleans	L. 511	18*
		D. 74	24†
		Purple	13†
1923	New Orleans	L. 511	17*
		D. 74	26†
		Purple	10†
1925	Baton Rouge	Purple	26†
		D. 74	32†
1926	Baton Rouge	Purple	30†
		D. 74	8†
1927	Baton Rouge	Striped	5*
		Purple	23†
1928	Baton Rouge	Striped	3*
		D. 74	15†
1929	Baton Rouge	D. 74	22†
		Striped	11*
1930	Baton Rouge	D. 74	12†
		Striped	6*
1931	Baton Rouge	D. 74	9†

* Plots planted with mosaic and healthy cane.

† Plots planted with selected and unselected cane.

TABLE 15. Effect of mosaic in replicated plots of some P.O.J. varieties in 1929, 1930 and 1931.

Year	Variety	Plant or Stubble Cane	YIELD TONS PER ACRE		Per cent Reduction Due to Mosaic
			Mosaic	Mosaic-free	
1929	P. O. J. 36-M	Plant	25.03	26.30	4.8
	P. O. J. 234	Plant	23.06	25.40	9.2
	P. O. J. 36	Plant	27.60	29.30	5.8
1930	P. O. J. 36-M	Plant	28.40	27.70	+2.5*
1931	P. O. J. 36-M	1st Stubble	26.9	28.2	4.6
	P. O. J. 36-M	Plant	26.5	28.3	6.3

* Increase.

YIELD TESTS IN 1933

In the fall of 1932, plats were planted at Baton Rouge with mosaic-free and mosaic-infected seed cane of P.O.J. 213, P.O.J. 234, and Co. 281. Each plat consisted of a 30-foot section of row in which 100 healthy eyes were planted. There were ten replications of each. Stand counts were taken during the year, and records obtained showing the spread of mosaic in the healthy plats. At harvest time (November 27-28, 1933), the stalks were counted and weights taken of each plat separately. Table 16 shows the results obtained at harvest time in the fall of 1933.

TABLE 16. Effect of mosaic in tests at Baton Rouge in 1933. The number of stalks, and tons per acre were obtained by averaging figures from the different plats. Each set of figures on sucrose, brix and purity represents average of five samples. The cane was cut November 27, 1933.

Variety	Disease Condition	Number of Stalks per Plat	Tons per Acre	% Reduction Due to Mosaic	Brix	Sucrose	Purity
P. O. J. 234....	Healthy.......	119	25.06		17.90	15.38	85.93
	Mosaic........	109	23.10	7.8	17.86	15.63	87.70
P. O. J. 213....	Healthy.......	135	27.24		16.78	13.82	82.36
	Mosaic........	121	24.72	9.1	16.88	13.88	82.13
Co. 281.......	Healthy.......	143	25.67		17.31	13.99	80.85
	Mosaic........	147	25.45	0.8	17.41	14.24	80.84

The differences in yields between the mosaic and healthy plats were probably significant in the varieties P.O.J. 234 and P.O.J. 213, but not in Co. 281, while the sucrose tests showed no differences worthy of note.

A similar test was conducted at Reserve in 1933 in which Co. 281 and P.O.J. 213 were used. The plats were larger—200 good eyes in 50-foot sections of row—and these were replicated seven times. There were irregularities in stands in some plats but these were eliminated from the final results as far as possible. However, as the variations in yield of the different plats were rather large, the results are not as reliable as in the test at Baton Rouge. Summary of the yield data is given in table 17.

TABLE 17. Effect of mosaic in tests at Reserve in 1933. The cane was cut November 17, 1933.

Variety	Disease Condition	Number Stalks per Plat	Tons per Acre	Per cent Reduction Due to Mosaic
P. O. J. 213............	Healthy.............	234	30.46	
	Mosaic.............	209	26.50	13.0
Co. 281...............	Healthy............	220	27.02	
	Mosaic.............	210	23.98	11.3

The results obtained at Reserve with Co. 281 differed somewhat from those at Baton Rouge. At Reserve, there was a reduction of approximately three tons to the acre due to the mosaic, while at Baton Rouge, there was practically none.

In addition to the above tests with commercial varieties, a small test was conducted in 1933 with C.P. 28-70. This variety had shown a severe stunting when affected with the yellow type of mosaic, and it seemed important to have some information on the actual loss which it causes. In the fall of 1932 replicated plats were planted at Baton Rouge with healthy cane and with cane affected with this type of disease. During the following season the stands were somewhat heavier and the cane considerably larger in the plats planted with healthy seed cane. The cane was cut on November 27, 1933. The results of the test are given in table 18.

TABLE 18. Effect of the yellow type of mosaic on C.P. 28-70 at Baton Rouge in 1933. The figures represent the average of 4 plots.

Disease Condition	Number Stalks per Plat	Tons per Acre	Per cent Reduction Due to Mosaic	Average Sucrose Content
Healthy	138	29.62		13.65
Yellow Mosaic	104	20.18	31.8	9.84

The results in table 18 show that severe damage may result from the yellow type of mosaic. Not only was the yield of C.P. 28-70 reduced 31.8% by the disease,

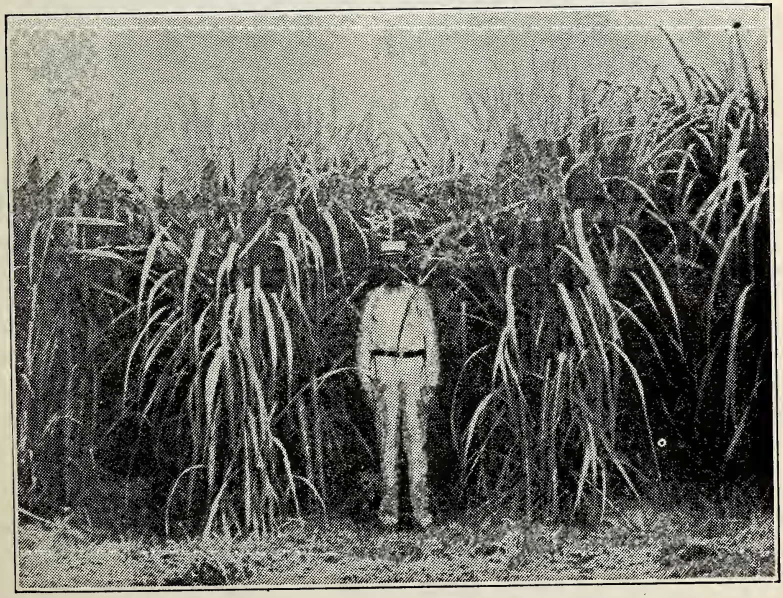

FIG. 5. Effect of mosaic on plant cane of P.O.J. 213. Row on left planted with mosaic-infected seed cane; row on right planted with mosaic-free seed cane.

but the sucrose content was also reduced 28%. This is apparently the first test reported (22) in Louisiana in which there has been a great reduction in both tonnage and sucrose due to the mosaic disease. These results are of considerable interest because of the fact that C.P. 28-70 might have become a valuable commercial variety if it had not been susceptible to this type of the mosaic.

YIELD TESTS IN 1934

In the fall of 1933, plats were planted at Baton Rouge with mosaic-free and mosaic-infected seed cane of the varieties, Co. 281, P.O.J. 213, Co. 290 and C.P. 29-291. Each plat consisted of a 50-foot section of a row in which 200 good eyes were planted. There were five replications with each variety. During the growing season of 1934, records were kept of the mosaic condition in the different plots. The disease spread rather rapidly in the plots of Co. 281 and P.O.J. 213 planted with healthy seed cane but only very slightly in Co. 290. The results of the test are given in table 19.

TABLE 19. Effect of mosaic in tests at Baton Rouge in 1934. Based on plats planted with 200 good eyes.

Variety	Mosaic or Healthy	Average No. of Stalks per Plat	Average Yield in Tons per Acre	Per cent Reduction Due to Mosaic	Average Sucrose Content
Co. 281	Healthy	244	21.43		13.98
	Mosaic	229	19.45	9.2	13.97
P. O. J. 213	Healthy	229	22.73		13.14
	Mosaic	193	18.70	17.7	12.47
Co. 290	Healthy	218	30.91		12.32
	Mosaic	240	30.64	0.8	12.69
C. P. 29-291	Healthy	225	28.87		12.37
	Mosaic	169	19.36	32.9	12.86

The differences in yield between the mosaic and healthy plots are probably significant with Co. 281, definitely significant with P.O.J. 213 and C.P. 29-291, but not significant with Co. 290, while the differences in sucrose content of the juice are not significant with any of the varieties. It should also be noticed that the reduction in yield of both Co. 281 and P.O.J. 213 apparently due to the mosaic disease, was greater in 1934 at Baton Rouge than in the preceding year. The general appearance of cane in the field is not materially affected when the loss from mosaic is not greater than that which occurred in these tests (See figures 5 and 6).

In a similar test conducted at Reserve in 1934, the varieties Co. 290, Co. 281, and P.O.J. 213 were used. Two rows, 363 feet long, were planted with healthy seed cane of each variety and two similar rows with mosaic-infected seed. During the growing season of 1934, mosaic spread to a large percentage of the cane in the plots of Co. 281 and P.O.J. 213 planted with healthy cane, but the spread was less in the Co. 290. Records were kept of the sucrose content of the juice and weights of the cane harvested. The results of the test are given in table 20.

TABLE 20. Effect of mosaic in tests at Reserve in 1934. Cane harvested December 6-7, 1934.

Variety	Healthy or Mosaic	Average Tons per Acre	Per cent Reduction Due to Mosaic	Average Sucrose Content
Co. 290	Healthy	42.48		12.13
	Mosaic	38.78	8.7	12.37
Co. 281	Healthy	28.30		14.08
	Mosaic	23.74	16.1	13.37
P. O. J. 213	Healthy	25.05		13.66
	Mosaic	19.30	22.9	10.86

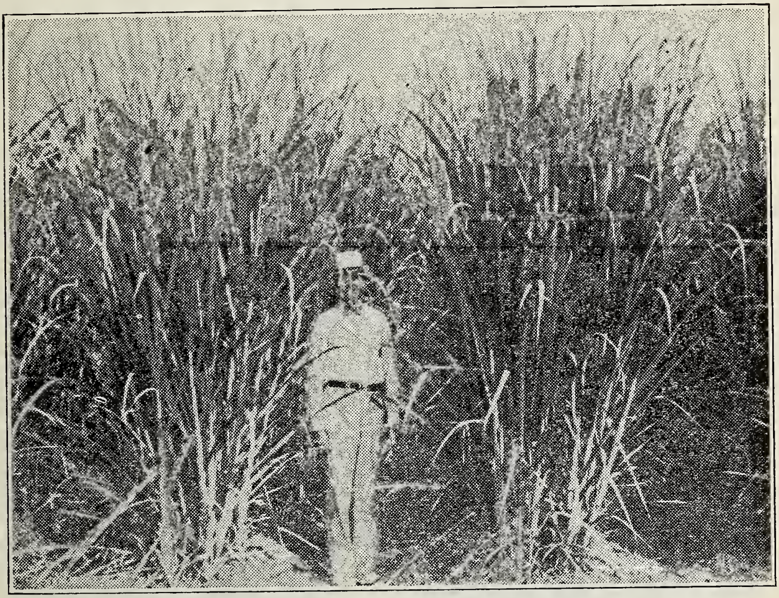

FIG. 6. Effect of mosaic on stubble cane of Co. 281. Row on left planted with mosaic-infected seed cane; row on right planted with mosaic-free seed cane.

Again in 1934, mosaic caused a greater reduction in yield at Reserve than at Baton Rouge.

In order to have more information on the effect of the yellow type of mosaic, the tests with C.P. 28-70 were continued in 1934. Small plots were planted with healthy cane and with cane affected severely with the yellow type. Again, as in the preceding year, all during the growing season the differences in size and color of the cane in the different plots were very pronounced. Plants from healthy seed cane were large, vigorous, and dark green, while those from diseased stalks grew slowly and were decidedly yellow. This was also true of the first year stubble plots which were carried over from the test of the preceding year (Fig. 7). In the fall, the plant and stubble cane from the tests was harvested. The results are presented in table 21.

TABLE 21. Effect of the yellow type of mosaic on C.P. 28-70 at Baton Rouge in 1934.

Plant or Stubble		Tons per Acre	Per cent Reduction Due to Mosaic	Sucrose Content	Pounds Sugar per Acre
Plant	Healthy	21.21		12.61	3287
	Yellow Mosaic	8.17	61.4	9.81	932
Stubble	Healthy	27.6		14.47	5134
	Yellow Mosaic	18.3	33.7	12.21	2763

Again, as in 1933 in the variety C.P. 28-70, the yellow type of mosaic caused a very severe reduction in tonnage and a very noticeable decrease in the sucrose content of the juice.

DISCUSSION ON YIELD TESTS

The yield tests which have been conducted over a period of years in Louisiana have given results which are apparently quite variable. It seems very probable,

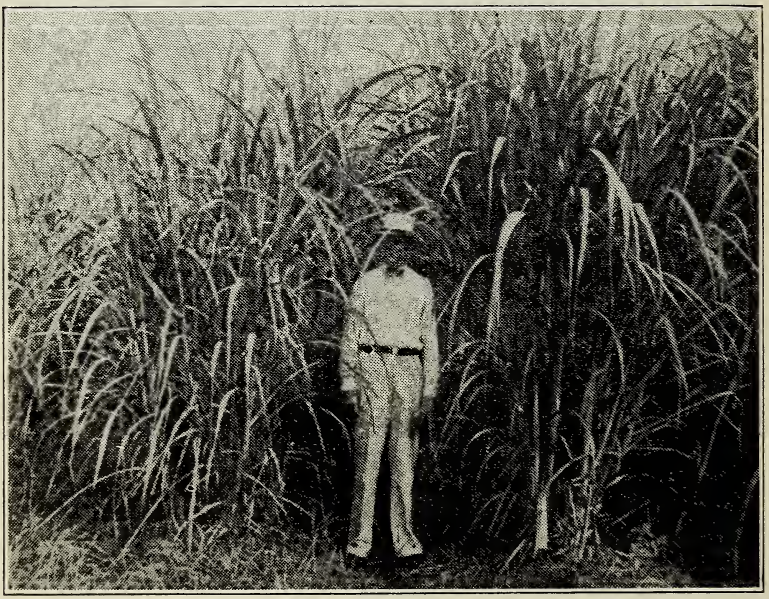

FIG. 7. Effect of yellow type mosaic on stubble cane of C.P. 28-70. Row on left planted with mosaic-infected seed cane; row on right planted with mosaic-free seed cane.

however, that these variations could be explained if all the factors affecting the development and the severity of the disease could be explained.

It is very evident that results obtained from a limited number of tests may be very misleading. Many factors, some of which are interesting, may affect the yield of cane in such tests. To draw conclusions from some of the tests which have been carried on in the tropics where very high losses of 40 to 60%, or on the other hand very small losses, have been reported would be decidedly unwise. It is very probable that other factors have affected these results to a certain extent.

It is not possible to explain and draw conclusions from all the results which have been obtained in Louisiana. Yet several things of interest stand out from the tests which have been conducted.

1. It is very evident that mosaic had a very considerable influence on crop production with the Noble canes in Louisiana, yet carefully conducted tests have not shown the losses from the disease which would be expected. Tests with the Louisiana Striped variety showed only moderate losses.

2. It was possible to select lines of D. 74 and Louisiana Purple which when used were affected very little by the mosaic disease. These lines were not free of mosaic but showed the disease in a very mild form. Recent tests, to be described later, suggest the probability that there may be differences in the virus causing sugarcane mosaic and that by selection the more virulent strains of the disease were eliminated.

3. Tests have shown that the mosaic disease is causing moderate losses in some of the P.O.J. and Coimbatore canes, such as P.O.J. 213 and Co. 281. These losses have been greater during the last couple of years than earlier. The losses have also been greater in some sections than in others. Whether these losses will increase in the future cannot be predicted.

4. Sugarcane plants showing the yellow type of mosaic symptoms are much more seriously injured than those showing the green type symptoms. Varieties showing even a moderate susceptibility to the yellow type are worthless from a commercial standpoint. Losses of more than thirty per cent can be expected.

INOCULATION TESTS

To obtain more definite information concerning the several factors affecting the development and spread of mosaic in Louisiana, inoculation experiments have been conducted on a rather large scale during a period of three years. In these experiments information on the following points seemed particularly desirable:

1. The amount of infection that can be produced in each variety by juice inoculations. Information on this should help to determine the relative resistance to infection of the several varieties and the rate of spread of the disease in the field.

2. The time of the year or the age of the plant when infection is most liable to occur in each variety.

3. The period of incubation or the time elapsing after the virus is inoculated into a plant before the first visible symptoms of the disease appear. This information should give some idea of how rapidly the virus develops and spreads in a plant and should give some idea of the relative resistance of the various varieties.

4. The reaction or behavior of the several varieties when inoculated with virus strains from different varieties.

Although several methods of inoculation were used, the one found to be most satisfactory was a slight modification of the spindle-puncture method described by

Matz (10). This method was used exclusively in the later tests. It consistently gave better results than inoculations with a hypodermic needle or by puncturing through living leaves into the spindle, a method which had been described by Sein (17).

The inoculum or virus used in all tests during the three years was obtained in the same way. Young leaves of mosaic-infected stalks were removed and the basal portions of the leaf nodes were ground through a food grinder with a fine-grinding unit. The grinder was cleaned before using by washing thoroughly in hot water and rinsing in 60% alcohol. The juice was extracted as rapidly as possible and squeezed through two to four layers of cheesecloth, after which it was put in containers and chilled in ice water, or in an ice box. In most of the inoculation tests, this juice was used within a few hours after it was extracted. When inoculations were to be made, some of this juice or virus was dropped into the spindle of the cane stalk with a pipette and then several punctures were made through the spindle with a fine-pointed needle. The needle carried the virus into the young growing parts of the cane plant.

TESTS IN 1932

The inoculation tests in sugarcane in 1932 were largely preliminary and the results obtained only furnished leads for later work. The inoculation tests were started on May 25 and extended over a period of about two months. The most successful tests were made early in the season, while the plants were comparatively small. Of six different sets of inoculations made later in the season during July, only one gave significant results.

Some of the results obtained in the early inoculation tests are of interest. The green type virus from P.O.J. 36 and P.O.J. 213 proved to be readily transmitted to Co. 281, P.O.J. 213 and P.O.J. 36-M. The incubation period in these varieties varied from 10 to 25 days. P.O.J. 234 did not contract the disease as readily as the other three varieties. A number of inoculations made on Co. 290 and C.P. 807 gave negative results.

Inoculation tests were also made with virus from C.P. seedlings affected with the yellow type of mosaic. Inoculations made with virus from C.P. 28-26 produced the green type of mosaic in Co. 281, but the percentage of infected plants was not as high as when the green type virus from Co. 281 was used.

Inoculations were also made in young corn plants. These were made to determine whether the yellow type virus from cane would produce symptoms on corn different from those produced by the green type virus. Viruses from six different sources were used; two yellow viruses from C.P. seedlings, three green type viruses from different varieties of cane, and one virus from corn. Yellow Creole corn growing in the field at Baton Rouge was used for inoculation. The plants were from two and one-half to three feet high when inoculated (June 21), and 50 plants were used with each virus. As there was only a very slight natural spread of mosaic in the surrounding plants, the results obtained were reasonably accurate. The first observations were made seven days after inoculation, several plants were then just beginning to show mosaic symptoms. Later observations were made after fifteen and twenty-two days. The data for these tests are given in table 22.

The high percentage of mosaic in plants inoculated with the virus from corn is of interest. Other tests made during the year gave very similar results. The mosaic symptoms in all of the plants as far as could be observed were indistinguishable.

ERRATA

The work presented in Table 22 was done in cooperation with Mr. Hugo Stoneberg, Specialist in Cereal Investigations, Bureau of Plant Industry.

Mr. Stoneberg has been detailed to the Louisiana Station and is carrying on investigations in the breeding of corn. It was an oversight that recognition of this cooperation was not made in the bulletin.

TABLE 22. Results obtained with Yellow Creole corn inoculated with mosaic viruses from sugarcane and corn. Fifty plants inoculated with each virus. Test started June 21, 1933.

Source of Virus	Type of Mosaic	Per cent of Plants Showing Mosaic Days After Inoculation		
		7 Days	15 Days	23 Days
Corn—Yellow Creole	Green	14	62	64
Cane—P. O. J. 213	Green	0	32	36
Cane—C. P. 28-57	Yellow	6	22	22
Cane—Co. 281	Green	4	18	20
Cane—P. O. J. 36-M	Green	6	26	34
Cane—C. P. 28-49	Yellow	0	20	22

TESTS IN 1933

The cane plants used in practically all the inoculation tests in 1933 were grown in a plot well isolated from other sugarcane or corn. The plot was kept free of grass and weeds to prevent natural infection as far as possible. Throughout the growing season, ony three infections occurred in the Co. 281 plants which were not inoculated, two in the C.P. 28-70, and none in P.O.J. 213, Co. 290, or C.P. 28-19. This shows that an isolated plot can be maintained relatively free from mosaic which will furnish satisfactory material for routine inoculation tests.

In 1933, satisfactory results were obtained from inoculation tests conducted during May and the early part of June when the cane was comparatively small and growing fairly rapidly. Tests made after the middle of June gave variable results. In some varieties, such as P.O.J. 213 and Co. 281, satisfactory infection was not obtained consistently during July and August. On this account, tests with these varieties made later than June 15—a number were made up to September 15—were considered unreliable and are not included here. On the other hand, the Purple, Striped and D. 74 varieties contracted the disease until late in the season. The difference in behavior of Co. 281 and Purple in this respect was very pronounced. In inoculation tests made in May or early June, the percentage of infection in the two varieties was very similar, although infection showed up earlier in Purple. In a similar test made in July, 70% infection occurred in Purple and none in Co. 281.

The inoculation tests in 1933 were conducted to give information on several questionable points regarding the mosaic disease.

1. *Inoculations with green type virus on different varieties:* Virus obtained from plants affected with the ordinary green type of mosaic was used to inoculate the common cane varieties. Co. 281, P.O.J. 213 and P.O.J. 36-M contracted the disease quite readily and from 60 to 100% infection was obtained when conditions were favorable. Usually from 12 to 15 days elapsed before mosaic symptoms showed on these varieties. The disease developed much more slowly in Co. 290. Visible symptoms of mosaic were not observed until 25 days after inoculation in a test, which eventually showed 65% infection at the end of 75 days. Most of the other tests were made too late in the season to give satisfactory results. C.P. 29-320 showed a small amount of natural infection in the field, but proved to be quite resistant to inoculation. More than 200 stalks of this variety were inoculated in a block of cane that was surrounded by diseased cane. Three of these stalks finally showed mosaic

symptoms, but the evidence indicates that these were natural infections and were not a result of the inoculation. The virus from C.P. 29-320 was readily transmitted to Co. 281. Attempts to inoculate healthy plants of C.P. 29-320 with vrius obtained from this Co. 281 were unsuccessful.

2. *Inoculations in C.P. 28-19:* A number of inoculation tests were made on C.P. 28-19 with the yellow type virus from the same variety and with green type viruses. Definite infection was produced in only one test, a test in which the C.P. 28-19 virus was used for inoculating plant cane. The first infection appeared after 12 days (on May 22), and 14 out of 20 plants showed the disease after 56 days. These plants showed mosaic symptoms quite distinctly in the latter part of July, but in October only 5 of the 14 showed mosaic symptoms. These five stalks were planted and some of the shoots which were produced in 1934 were diseased and others appeared to be healthy. The stubble cane developing from the inoculated plants came up free of mosaic with the exception of one plant. As no mosaic appered in the several thousand stalks in the same rows which were not inoculated, it is safe to say that the infection was due to the inoculation. This test is of particular interest because all inoculations in C.P. 28-19 since then have been unsuccessful.

3. *Inoculations on Selected D. 74 and Louisiana Purple:* As reported in earlier papers (7) strains of Louisiana Purple and D. 74 which showed the mosaic disease in a very mild form were obtained by selection. These plants were in no sense free from mosaic as a faint mottling could be observed on the leaves when conditions for growth were favorable. It seemed of interest to find how these plants would react when inoculated with virus from plants showing pronounced symptoms of the disease.

Mosaic virus from Louisiana Striped cane was inoculated into stalks of selected D. 74 and also into healthy stalks of C.P. 28-19, Co. 281, Louisiana Striped and Louisiana Purple on July 12. This was after the most favorable period for infection. Only one infection showed on Co. 281 and none on C.P. 28-19, but mosaic symptoms appeared on Striped and Purple after fifteen days and 80% of the plants were found to be infected twenty-three days later. The selected D. 74 plants began to show symptoms of new infection 13 days after inoculation and 17 days later, 85% of the plants showed typical symptoms of the disease. The symptoms produced on the selected D. 74 were typical of those observed in the ordinary unselected cane of this variety. This test was repeated on selected strains of both D. 74 and Louisiana Purple using plants showing the very faint mosaic mottling characteristic of the selected cane and very similar results were obtained. These tests indicate that by selecting for mosaic resistance, strains of these varieties were obtained which either contained an attenuated virus or a very mild form of virus. By selection, the ordinary mosaic type was eliminated, but the selected plants were still susceptible to this virus as indicated by the inoculation tests.

4. *Inoculations with virus from C.P. 28-70:* As observed earlier in this bulletin, two entirely different types of mosaic symptoms occur on the C.P. 28-70. These are the common mild or green type and the yellow or severe type. These two mosaic types also occur in certain other C.P. seedlings, including C.P. 28-57 and C.P. 29-314.

The inoculation tests made in 1932 indicated that there might be two distinct viruses affecting C.P. 28-70. A number of stalks showing the green type and others with the yellow type symptoms were planted separately in 1932. All the shoots coming from stalks with the green type showed the same green symptoms throughout the 1933 growing season.

With the exception of a few which showed no mosaic symptoms, the shoots growing from stalks with the yellow type showed yellow symptoms when they came up. The two types of mosaic remained the same all through the year.

On May 11, a series of inoculations was made with the two viruses (green and yellow) from C.P. 28-70 to C.P. 28-70 and Co. 281. The first infection showed after 16 days in plants of C.P. 28-70 inoculated with the green type virus, and 20 days later 11 of the 15 inoculated plants showed green symptoms, although 14 days later, 5 of the 11 stalks showed yellow type symptoms. The yellow type inoculated plants showed mosaic 36 days after inoculation, with 75% infection after 75 days. Both viruses produced the ordinary green type symptoms in Co. 281. In most tests on both C.P. 28-70 and Co. 281, a much greater number of infections resulted from the green type virus. In most of the tests when the green type virus was inoculated into C.P. 28-70, both yellow and green type symptoms were produced, but the yellow type virus invariably produced only symptoms of the yellow type.

The yellow type virus from a number of other C.P. seedlings invariably produced the ordinary green type symptoms in Co. 281, P.O.J. 213, Purple and Striped but usually the yellow type virus was not as easily transmitted as was the green type.

The results obtained in 1933, while not conclusive still indicated that there are distinct virus strains. The somewhat variable results which were obtained might have been due to the use of mixed viruses in the tests.

Tests in 1934

Beginning early in May and continuing until October, a comparatively large number of inoculation tests were made in 1934. In the later tests made from August to October, young cane plants grown from seed pieces planted in July were used. In general, the results in 1934 were similar to those of 1933 in that inoculations made early in the season were more successful than those made later. Inoculations made after the first of July excepting those on Purple, Striped and C.P. 28-70 were generally unsatisfactory. Fairly good results were obtained with these three varieties as late as August.

1. *Inoculations with green and yellow type viruses.* In 1934, inoculation experiments were conducted using the green and yellow type viruses. It seemed important to determine the reaction of viruses from such varieties as C.P. 28-70 and C.P. 29-314, which show both the green and yellow types of mosaic, when inoculated into healthy plants of different varieties.

In the first test started on May 9, the yellow and green type viruses from C.P. 28-70, the yellow type from C.P. 28-19 and the green type from Co. 281 were used. Each virus was obtained by crushing and extracting the juice from the young leaves of a number of different plants. This method may be subject to criticism as it is perhaps possible for a single stalk to have more than one virus and when a number of stalks are used, the chances of this occurring are rather high. These viruses were inoculated into healthy stalks of C.P. 28-70, Co. 281, C.P. 29-320 and C.P. 28-19. Twenty stalks of each variety were inoculated with each virus. The results of this test are given in table 23.

It is interesting to note that the yellow type virus from C.P. 28-70 and the green type from Co. 281 produced only the yellow type on C.P. 28-70, while the green type virus from C.P. 28-70 produced both types on the same variety. The resistance of C.P. 29-320 and C.P. 28-19 to inoculation by the method used is also of interest.

Another test, started on June 4, was conducted in practically the same way. However, more varieties were inoculated and yellow and green viruses from C.P. 29-314 were also used. The results of this test are given in table 24.

TABLE 23. Results of inoculations with yellow and green type viruses, 20 plants of each variety inoculated. Inoculations made May 9, 1934.

Source of Virus	Virus Type	Varieties Inoculated	Incubation Period—Days	Per cent Developing Green Mosaic	Per cent Developing Yellow Mosaic
C. P. 28-70......	Yellow......	C. P. 28-70..........	16	0	45
	Yellow......	Co. 281.............	12	50	0
C. P. 28-70......	Green.......	C. P. 28-70..........	12	40	35
	Green.......	C. 281..............	9	70	0
Co. 281.........	Green.......	C. P. 28-70..........	12	0	60
	Green.......	Co. 281.............	19	60	0
	Green.......	C. P. 29-320.........	..	0	0
C. P. 28-19......	Yellow......	C. 281..............	30	10	0
	Yellow......	C. P. 28-19..........	..	0	0
	Yellow......	C. P. 29-320.........	..	0	0

The results obtained in this test are mostly similar to those obtained in the earlier one. The yellow type of mosaic was produced on C.P. 28-70 by virus from plants of the varieties C.P. 28-70 and C.P. 29-314 affected with the yellow mosaic and from plants of Co. 281 affected with the green mosaic. The very small percentage of this variety developing green mosaic when inoculated with these viruses is probably not significant. On the other hand, in this test, the green type virus from C.P. 28-70 produced only the green mosaic when inoculated in the same host. The short period of incubation shown by the Purple cane is also of interest.

As suggested on a previous page, there was a strong probability that mixed viruses were being used in some of these inoculation tests. To obtain some information on this point, virus was extracted separately from twelve individual stalks of C.P. 28-70 which showed the typical green type symptoms. Ten stalks of C. P. 28-70 were inoculated with each virus on June 11. When the last observations were made on these plants 50 days later, the infection percentages ranged from 10 to 100, with the different viruses, most of them being between 50 and 100. Out of the 120 stalks inoculated, only one showed yellow type symptoms throughout the season. These results suggested that only one virus type was present in most of the stalks which were used for extracting the juice. However, these inoculations were made rather late in the summer and as has already been mentioned, tests under such conditions are not always significant. That this might be the case was brought out by a small test made on July 7. On that date, stalks of C.P. 28-70 showing green mosaic symptoms were inoculated with yellow type virus from the same variety. Yellow type symptoms did not appear on any of these plants though infection readily developed on stalks of Purple cane inoculated at the same time with the same virus.

Although the results which were obtained from the inoculation tests suggested the possible existence of two distinct virus types in C.P. 28-70, there remained the

TABLE 24. Results of inoculations with yellow and green type viruses. 15 plants of each variety inoculated unless otherwise stated. Inoculations made June 4, 1934.

Source of Virus	Virus Type	Varieties Inoculated	Incubation Period—Days	Per cent Developing Green Mosaic	Per cent Developing Yellow Mosaic
C. P. 28-70	Yellow	C. P. 28-70	16	6.6	20.0
	Yellow	Co. 281	23	26.6	0.0
	Yellow	C. 290	23	26.6	0.0
	Yellow	C. P. 28-19	..	0.0	0.0
	Yellow	Purple*	8	80.0	0.0
	Yellow	P. O. J. 213*	16	60.0	0.0
C. P. 28-70	Green	C. P. 28-70	16	100.0	0.0
	Green	Co. 281	23	86.6	0.0
	Green	C. 290	50	6.6	0.0
	Green	C. P. 28-19	..	0.0	0.0
	Green	Purple*	8	80.0	0.0
	Green	P. O. J. 213*	16	80.0	0.0
Co. 281	Green	C. P. 28-70†	32	0.0	15.0
	Green	C. 281	23	80.0	0.0
	Green	Co. 290	23	40.0	0,0
	Green	C. P. 28-19	..	0.0	0.0
	Green	Purple*	8	100.0	0.0
	Green	P. O. J. 213*	16	80.0	0.0
C. P. 29-314	Yellow	C. P. 28-70	23	6.6	13.3
	Yellow	C. 281	23	26.6	0.0
	Yellow	Co. 290	..	0.0	0.0
	Yellow	C. P. 28-19	..	0.0	0.0
C. P. 29-314	Green	C. P. 28-70	16	93.3	0.0
	Green	Co. 281	23	66.6	0.0
	Green	Co. 290	23	60.0	0.0
	Green	C. P. 28-19	..	0.0	0.0

* Only 5 plants inoculated.
† 20 plants inoculated.

possibility that there might be two genetically different canes included in this variety as it was being grown and that the same virus would produce green symptoms in one and yellow in the other. To eliminate this possibility a test was made to determine whether different shoots growing from the same stalk might be inoculated with the different viruses and both types of mosaic produced. Twenty healthy stalks of C.P. 28-70 were cut into half and planted in the greenhouse. The young shoots from one-half of each stalk were inoculated with the yellow type virus from C.P. 28-70 and those from the other half with the green type virus. After 30 days, shoots from 3 of the stalks which had been inoculated with the yellow type virus developed the yellow mosaic, while other shoots from the same stalks inoculated with the green type virus produced green mosaic. This showed conclusively that both virus types may occur in shoots developing from the same stalk of C.P. 28-70.

2. *Miscellaneous Inoculation Tests:* Some interesting results were obtained from the routine inocualtion tests which were conducted during the growing season of 1934. The newly introduced C.P. seedlings, 28-11, 28-19, and 29-320, showed some natural mosaic infection at Baton Rouge as well as in other parts of the state.

All three of these varieties, however, proved to be quite resistant to inoculation. No positive infections were produced in any of the three varieties during 1934. Howver, the viruses of C.P. 29-320 and C.P. 28-11 when inoculated in Co. 281, P.O.J. 213, and some other susceptible varieties produced the ordinary green mosaic symptoms readily. The results of a single test with the C.P. 29-320 virus are given in table 25.

TABLE 25. Results of a test with virus from C.P. 29-320. Inoculations made May 10, 1934.

Varieties Inoculated	Number of Stalks Inoculated	Incubation Period—Days	Number of Plants Developing Mosaic
C. P. 29-320	40	34	1*
La. Purple	10	11	10
P. O. J. 213	20	15	19
Co. 290	20	18	12
Co. 281	20	18	16

* The single infection is probably not significant.

This test showed that the C.P. 29-320 virus was quite readily transmitted to susceptible varieties, but the method used did not reinfect C.P. 29-320 to any appreciable extent. A number of other tests made during 1934 gave similar results.

The virus from C.P. 28-19 apparently is much less infectious than most of the other viruses tested. No clear cut infections were produced with this virus when inoculated in such susceptible varieties as Co. 281 and P.O.J. 213.

Co. 290 proved to be moderately resistant to artificial inoculation in most of the tests. This was evident from the low percentage of infection and the comparative slowness of the symptoms in developing. The first infections developed as early as 12 days after inoculation, but some others continued to develop as long as 60 days after inoculation.

P.O.J. 213 and Co. 281 proved to be about equally susceptible to inoculation. A high percentage of infection developed from most of the inoculations with the green type viruses when made under conditions favorable for mosaic development. During July and August after the stalks had formed a number of mature joints, these varieties did not contract the disease readily.

The Striped and Purple varieties were the most susceptible ones used in various tests. They usually contracted the disease earlier than other varieties (6-8 days after inoculation) and within a few days often showed 100% infection. Another conspicious difference between these varieties and the other very susceptible varieties (Co. 281 and P.O.J. 213) was their susceptibility to mosaic inoculation all during the summer. For example, a set of inoculations was made on Striped and Co. 281 in August, 1934. About 100% infection developed in the Striped cane and none at all in the Co. 281.

Although mosaic has apparently developed in C.P. 807 under field conditions, all efforts to inoculate stalks of this variety have failed. The C.P. 807 virus and a number of other viruses have been used but no infections have as yet been produced.

3. *Inoculations in suckers:* From observation it has been known that in such susceptible varieties as Purple, P.O.J. 213, and Co. 281, the mosaic virus spreads quite rapidly from the main shoot of a stool to the suckers which develop at its base. It has also been demonstrated that when the main shoots are inoculated, suckers

which are already well-developed will show mosaic symptoms about as quickly as the main shoots themselves. The spread in the reverse direction, from the suckers to the main shoot does not ordinarily take place as readily. To obtain more definite information on this point, a test was conducted in June, 1934. Using the varieties Co. 281, P.O.J. 213 and Louisiana Purple, three suckers were inoculated in each of 15 stools, the main shoot in each stool not being inoculated. Records were kept of the mosaic developing in both the suckers and main shoots. The results are presented in table 26.

TABLE 26. Results of inoculation tests to determine whether mosaic spreads from the suckers to the main shoot. Three suckers in each of fifteen stools inoculated with green type virus from P.O.J. 36-M on June 12, 1934.

Varieties Inoculated	Days Before Mosaic Appeared—		Number Developing Mosaic	
	In Suckers	In Main Shoots	Suckers	Main Shoots
Co. 281..........	27	54	36	1
P. O. J. 213........	27	27	41	4
La. Purple.........	8	27	45	7

With all varieties, the mosaic spread from the suckers to the main shoots, although in Co. 281, only one main shoot out of fifteen developed the disease as compared to seven in Purple. The disease also in most cases appeared later in the main stalks than in the suckers.

Summary of Inoculation Tests

From the inoculation tests which have been conducted during a period of three years, some interesting facts and ideas regarding the mosaic disease of sugarcane have been brought out:

1. Usually, inoculation experiments in Louisiana have been more successful during the early part of the growing season, especially during May and early June. This agrees very well with results which have been reported in various sugar producing countries of the tropics. It has been generally recognized that mosaic spreads more rapidly during the early part of the growing season. However, the inoculation experiments have shown that varieties differ to some extent in regard to the period of growth during which they are susceptible. Inoculation experiments with certain of the old Nobles canes such as D. 74, Louisiana Purple and Striped and also with some of the newer canes such as C.P. 28-70, have been fairly successful late in the summer, at a time when it was very difficult to inoculate such varieties as Co. 281 and P.O.J. 213.

2. The period of incubation, or the period of time elapsing between the inoculation of the virus from an infected sugarcane plant into a healthy plant and the appearance of visible symptoms of the mosaic disease varies to a considerable extent with the different cane varieties. In general, the period of incubation is longer with those varieties which are generally considered more or less resistant or tolerant to the mosaic disease.

3. Considerable evidence has accumulated confirming the theory that different

strains of mosaic virus do occur. Whether this is due to a virus becoming either attenuated, or on the other hand, more closely specialized on some particular sugarcane variety or whether there are distinct differences in certain viruses cannot, of course, be demonstrated.

Two very distinct types of mosaic, now being called the yellow and the green mosaic, recognized by very unlike symptoms, occur in Louisiana. That such unlike symptoms might be produced by the same virus on different varieties is, of course, possible but this explanation is not entirely satisfactory. It is true that the virus from plants affected with the yellow mosaic when inoculated into varieties like Co. 281 will produce the green type symptoms. On the other hand, both types of the mosaic may occur in a single variety and the very definite symptoms do not change as the plants are propagated from year to year. Furthermore, viruses obtained from such plants and used for inoculation purposes have usually produced similar symptoms. There have been some exceptions to this but these have probably resulted from the use of mixed viruses.

It is also of interest to note that virus from Co. 281, which ordinarily shows the green type symptoms, produces the yellow type mosaic when inoculated into varieties like C.P. 28-70. This is very suggestive and may possibly offer an explanation for the resistance shown by such varieties as Co. 281 and P.O.J. 213 during a number of years. It seems probable that the susceptibility which is shown at the present time is due to the presence of a virus which is not generally distributed during the earlier years. The absolute proof of these theories will, however, require considerable more experimentation.

4. It also seems possible that the presence of more than one strain of the mosaic virus or the occurrence of attenuated strains is the explanation of the results that were obtained in earlier years in selected lines of the Noble canes such as D. 74 and Louisiana Purple which showed the mosaic in a very mild form. The fact that these selected plants can be inoculated with the ordinary type of mosaic shows that they are not immune or even tolerant. In the selection work, plants infected with the more virulent mosaic strains were evidently eliminated.

SUMMARY

1. The mosaic disease has been an important factor in sugarcane production in Louisiana for fifteen years or more. The decline of the sugar industry which occurred during this period can at least be partially attributed to this disease. In the recovery of the industry which has taken place during recent years, varieties resistant or tolerant to the disease have been used as far as possible.

2. The mosaic disease spreads rapidly in susceptible varieties in the southern part of the area, but in the northern section, especially around Bunkie, the infection has consistently remained low even when susceptible varieties have been planted.

3. In Louisiana, two distinct mosaic types characterized by symptoms which are definite and constant, occur. These are being called the green or mild mosaic and the yellow or severe mosaic. The green mosaic is the ordinary type seen on such commercial varieties as P.O.J. 213 and Co. 281. The yellow mosaic which is characterized by very severe mottling and frequent necrosis of the chlorotic areas is more often seen on certain of the new C.P. seedlings. In some cases, both mosaic types occur on the same variety.

4. Sugarcane varieties have not always shown the same resistance to mosaic.

Some varieties, as for example P.O.J. 213 and Co. 281, remained very resistant to mosaic for a number of years and then suddenly became very susceptible. These two varieties were considered resistant until about 1931 but since then they have been very susceptible. It appeared as if a more virulent strain of the mosaic to which these varieties were susceptible became established in the river area in about 1930 and from there spread out over the whole Sugar Belt.

5. The new cane varieties which now seem the most promising are not immune to mosaic. The yellow type of mosaic occurs to a very limited extent in C.P. 28-11 and C.P. 28-19, while the green type occurs in C.P. 29-320. As yet, no field of these canes in the state shows a percentage of mosaic high enough to be of any economic importance.

6. Certain varieties are able to throw off the mosaic and apparently recover from the disease. The mosaic symptoms may gradually disappear from mature plants growing in the field or disease-free shoots may grow from stalks known to be infected with the disease.

7. A very high percentage of mosaic infected plants of the varieties P.O.J 213 and P.O.J. 228 recovered from the mosaic disease previous to 1931, during the period when the former variety was considered as very resistant to the disease. The low percentage of mosaic commonly observed in the field during that period was apparently due to the recovery of plants that did become infected. After mosaic began to spread rapidly in P.O.J. 213, there was very little recovery from the disease. This again is evidence confirming the theory that a more virulent strain of the mosaic became established in the state in about 1930.

8. Of the newer varieties, recovery is common in C.P. 29-320 and C.P. 28-11, and sometimes occurs in C.P. 28-19.

9. Infective virus is not always absent from plants which have apparently recovered from the disease. In some cases, the disease has been produced by inoculating juice from such plants into healthy plants. The percentage of infection, however, when such juice has been used has not been high.

10. Mosaic is sometimes responsible for a slight reduction in germination of the eyes. This has been observed with Louisiana Purple, Louisiana Striped, D. 74 and possibly with P.O.J. 213. Consistent reductions in stand have not been observed with Co. 290 or Co. 281.

11. The losses in tonnage due to the mosaic disease have varied to a considerable extent in tests which have been conducted. The losses in P.O.J. 36, P.O.J. 36-M, and P.O.J. 234 have not been large. The losses in P.O.J. 213 have usually run from 10 to 18%, while the results with Co. 281 have been variable. At Baton Rouge the mosaic has only caused slight reductions in tonnage of Co. 281, while at Reserve, reductions of 10-20% have been noted. Co. 290 also showed some reduction in tonnage in a single year's test at Reserve, while at Baton Rouge, the loss was insignificant. No data are available at present on the effect of mosaic on yields of the newer varieties, C.P. 28-11, C.P. 28-19 and C.P. 29-320.

12. Reductions in yield are much more severe when the plants are affected with the yellow type of mosaic than when affected with the green type.

13. There has been no significant difference in the sucrose content of juice from healthy and mosaic-infected cane in any variety tested except C.P. 28-70. In canes of this variety affected with the yellow mosaic, the sucrose content has been considerably reduced.

14. Inoculation tests have been conducted over a period of three years. Satis-

factory results have been obtained with the spindle-puncture method of inoculation.

15. In general, inoculation experiments have been more successful during the early part of the growing season, especially during May and the early part of June. During that period, infection is readily obtained on most susceptible varieties. Later in the summer, infection is not so readily obtained in varieties that ordinarily show resistance to the disease. On very susceptible varieties, however, infection is readily obtained much later in the summer.

16. The incubation period in very susceptible varieties is ordinarily shorter than in varieties showing some resistance to mosaic.

17. The inoculation tests have shown that Co. 281 and P.O.J. 213 are as susceptible to inoculation early in the season as are Louisiana Purple, Louisiana Striped and D. 74, while Co. 290 seems somewhat more resistant. Successful inoculations have not been obtained in C.P. 28-11, C.P. 29-320 and C.P. 807 and only once in C.P. 28-19.

18. Stubble cane of some varieties is apparently less susceptible to artificial inoculation than plant cane. This was especially noticeable in Co. 281.

19. Successful infection has been obtained with viruses from plants showing the green type symptoms and also with those showing the yellow type symptoms.

20. Both the yellow and green types of mosaic occur in the variety C.P. 28-70. Viruses obtained from infected plants of this variety have usually produced similar symptoms when inoculated in healthy plants of the same variety. Virus from plants showing the yellow mosaic symptoms produces yellow mosaic and virus from plants with the green symptoms produces the green mosaic. There have been some exceptions to this but these have probably followed the use of mixed viruses.

21. Virus from plants of the Co. 281 variety which show green symptoms, invariably produces the yellow type of mosaic when inoculated into C.P. 28-70.

22. In selected strains of D.74 and Louisiana Purple which show mosaic in a very mild form, a very pronounced form of mosaic can be produced by inoculating with a virulent virus.

23. In susceptible varieties, mosaic spreads quite rapidly from the inoculated main shoot to the suckers produced at the base. It will also spread from suckers to the main shoot though this does not seem to be so rapid.

24. From the work carried on with sugarcane mosaic, the evidence suggests that there are a number of viruses which physiologically are different. These viruses sometimes produce different symptoms, but in other cases, are shown to be different only by their ability to attack certain cane varieties.

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JULY, 1935 LOUISIANA BULLETIN No. 264

The Growth of Population in Louisiana
1890 to 1930

By
T. LYNN SMITH

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THE GROWTH OF POPULATION IN LOUISIANA
1890 TO 1930

By

T. LYNN SMITH

INTRODUCTION

This bulletin contains a discussion of the growth of population in the State of Louisiana. The period covered is the forty-year interval 1890 to 1930. This discussion is the first of a series of three reports presenting the findings from a study of the State's population that has been under way at the Louisiana Agricultural Experiment Station for the past two years. Reports to follow will be concerned with: (1) The Composition and Characteristics of the Population; (2) The Origin, Nature and Extent of Migration to the State.

In the following pages an attempt is made to summarize the momentous changes which have taken place in Louisiana's population during the last forty years. First, the increases that have occurred during this period are summarized. Next, those areas are identified in which the most rapid increases or decreases in population have occurred, and some discussion presented of the factors associated with these gains and losses. Following this, attention is given to the comparative gains made by the various elements in the population, such as white and negro, urban and rural, etc. Special attention is next concentrated upon the comparative increases of population in the various type-of-farming areas of the State. Throughout the study, a constant attempt is made to relate population changes to the factors responsible for them.

Reports of the United States Census Bureau have provided the bulk of the data for this study. Careful attention has been given to the problem of the comparability of the various categories from one census to another. The period covered in the study was not extended to the decades previous to 1890, because reports for these years are lacking in many of the essential classifications.

Some terms are used in the following pages which should be clarified here. In the first place, population centers are divided into several groups and each category given a distinctive title. As used in the following pages:

Small Village= An incorporated center with less than 1,000 inhabitants.

Large Village= An incorporated center with between 1,000 and 2,500 inhabitants.

Small Town= An incorporated center with between 2,500 and 5,000 inhabitants.

Large Town= An incorporated center with between 5,000 and 10,000 inhabitants.

Small City= An incorporated center with between 10,000 and 100,000 inhabitants.

Large City= An incorporated center with over 100,000 inhabitants.

Omitting Orleans, which is co-extensive with the city of New Orleans, the remaining 63 parishes (counties) were grouped into five type-of-farming areas. These are "Upland Cotton," "Delta Cotton," "Rice," "Cane," and "Small Fruits and Vegetables." The major criterion used in classifying a parish was the proportion of crop land devoted to each of the above products, although the distinction between the upland and delta cotton regions was made on the basis of topography. As used in this study, the classification of the parishes into type-of-farming areas is as follows:

UPLAND COTTON

Beauregard
Bienville
Caldwell
Cameron
Claiborne
DeSoto
East Baton Rouge
East Feliciana
Evangeline
Grant
Jackson
Lafayette
LaSalle
Lincoln
Morehouse
Ouachita
Sabine
St. Helena
St. Landry
Union
Vernon
Washington
Webster
West Feliciana
Winn

DELTA COTTON

Avoyelles
Bossier
Caddo
Catahoula
Concordia
East Carroll
Franklin
Madison
Natchitoches
Pointe Coupee
Rapides
Red River
Richland
Tensas
West Carroll

RICE

Acadia
Allen
Calcasieu
Jefferson Davis
Vermillion

CANE

Ascension
Assumption
Iberia
Iberville
Lafourche
St. James
St. John the Baptist
St. Martin
St. Mary
Terrebonne
West Baton Rouge

SMALL FRUITS AND VEGETABLES

Jefferson
Livingston
Plaquemines
St. Bernard
St. Charles
St. Tammany
Tangipahoa

INCREASE OF POPULATION 1890 TO 1930

The period 1890 to 1930 marked a very rapid growth of population in the State of Louisiana. The residents of the Commonwealth who numbered only 1,118,588 in 1890 had increased to 2,101,593 by 1930, making a gain of 87.9 per cent. This represents, during the 40 year period, an annual rate of increase amounting to 1.53 per cent. As a help in visualizing the growth of the State's population, Figure 1 was constructed. It shows the total population at the end of each decade since the "Louisiana Purchase," together with the percentage increase of the population during each decade. This graph makes it evident that during the last forty years population grew most rapidly during the decade 1890 to 1900 when the annual rate of increase was 2.13 per cent. The growth was least rapid between 1910 and 1920, only .87 per cent annually. The rate was up again (1.66 per annum) for the decade 1920 to 1930. However, Figure 1 shows that the rate of increase in the last few decades is but a fraction of that which prevailed throughout the nineteenth century. The rapidity with which the population of the State has been growing may be comprehended better by recalling that a single pair reproducing at the rate of one per cent per annum would equal 1,700,000,000—the present population of the earth—in 2,000 years; and that the present rate at which the population of the world is expanding is approximately one per cent per annum.*

To get a clearer understanding of the trends of population in Louisiana, it is necessary to compare the data presented above with those for the Union as a whole and its component states. Between 1890 and 1930, the population of Continental United States (excluding Alaska) increased 95.0 per cent. This rate is slightly higher than that of Louisiana. Twenty-five of the states likewise grew more rapidly than Louisiana. But it is important to note that, of the twenty-five, twelve were in the wide, open and sparsely populated sections of the Far West—Arizona, California, Idaho, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming. Six others were in the highly industrialized and urbanized Northeast—Connecticut, Massachusetts, Michigan, New Jersey, New York and Rhode Island. In the entire South, (the most comparable section) only North Carolina, Florida and Texas exhibited rates of population increase which exceeded that in Louisiana.

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* A. M. Carr-Saunders, Population, p. 12.

If only the white population is considered, the rate of increase in Louisiana was exceeded by only eleven Western states, one Eastern state (New Jersey) and two Southern states, (Florida and Texas). On the other hand, if a comparison of the increases in negro population is made, Louisiana occupies a median position among Southern states. The negro population of Louisiana increased less rapidly than that of Alabama, Arkansas, Florida, Mississippi, North Carolina and Texas. But it grew more rapidly than that of Georgia, Kentucky, South Carolina, Tennessee and Virginia.

The data presented above should be sufficient to show that the population increase in Louisiana has kept pace with the very rapid rate for the United States as a whole. But in order to grasp the real situation, two additional points must be kept in mind. This increase has taken place despite the facts that: (1) the State has received practically none of the millions of immigrants from foreign countries; and (2) the State has given more migrants to the other states of the Union than it has received from them.

The relatively unimportant role played by migration to the State from foreign countries is easily shown. In 1930 there were only 37,076 foreign-born in Louisiana, only 1.8 per cent of the population, while in the United States as a whole, 11.6 per cent of the population was foreign-born.* It is interesting to note that out of all the states in the Union only ten Southern states (Alabama, Arkansas, Georgia, Kentucky, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee and Virginia) contained smaller proportions of foreign-born than Louisiana.

Louisiana's contribution of population to other states is shown by the following: in 1930, 386,208 persons born in Louisiana were living in other states of the Union, while only 269,269 persons born in the other states were living in Louisiana. This means that the State of Louisiana had made a net contribution to the remaining states of the Union of 116,939 persons. The majority of these were negroes (107,428), the net loss of white persons being only 8,784.

GROWTH OF POPULATION BY AREAS

The expansion of population has proceeded at very different rates in the various parts of the State. In some regions the population has increased with remarkable speed, doubling in the interval between 1890 and 1930. While in others, the total number of in-

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* 14,204,149 persons were classed as foreign-born by the 1930 census.

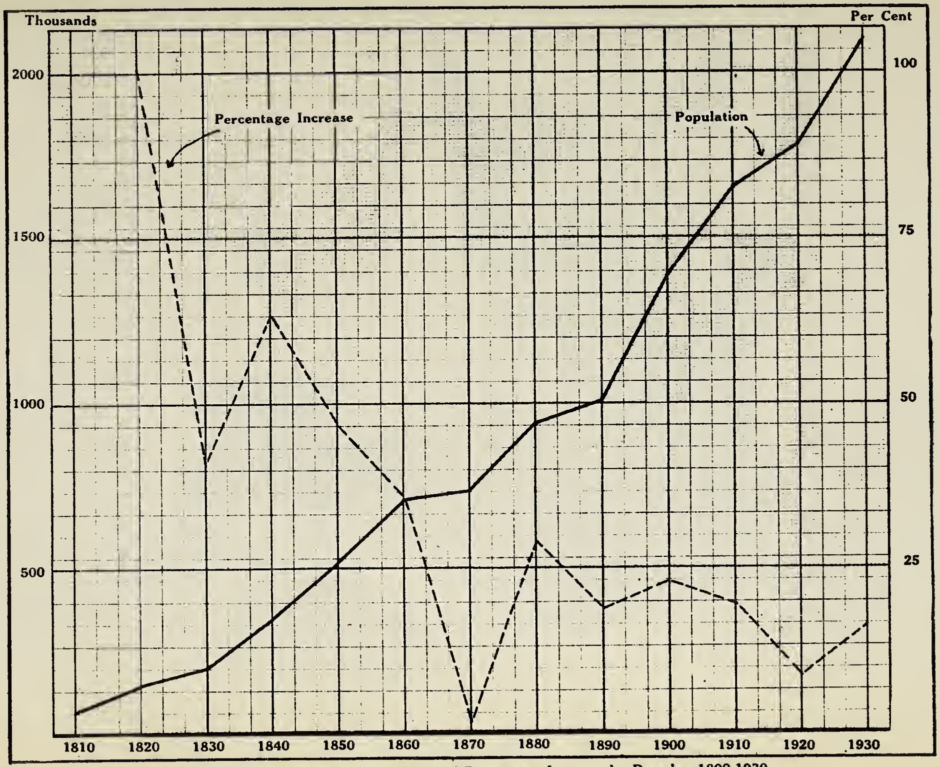

Figure 1.—Population of Louisiana and Percentage Increase by Decades, 1890-1930.

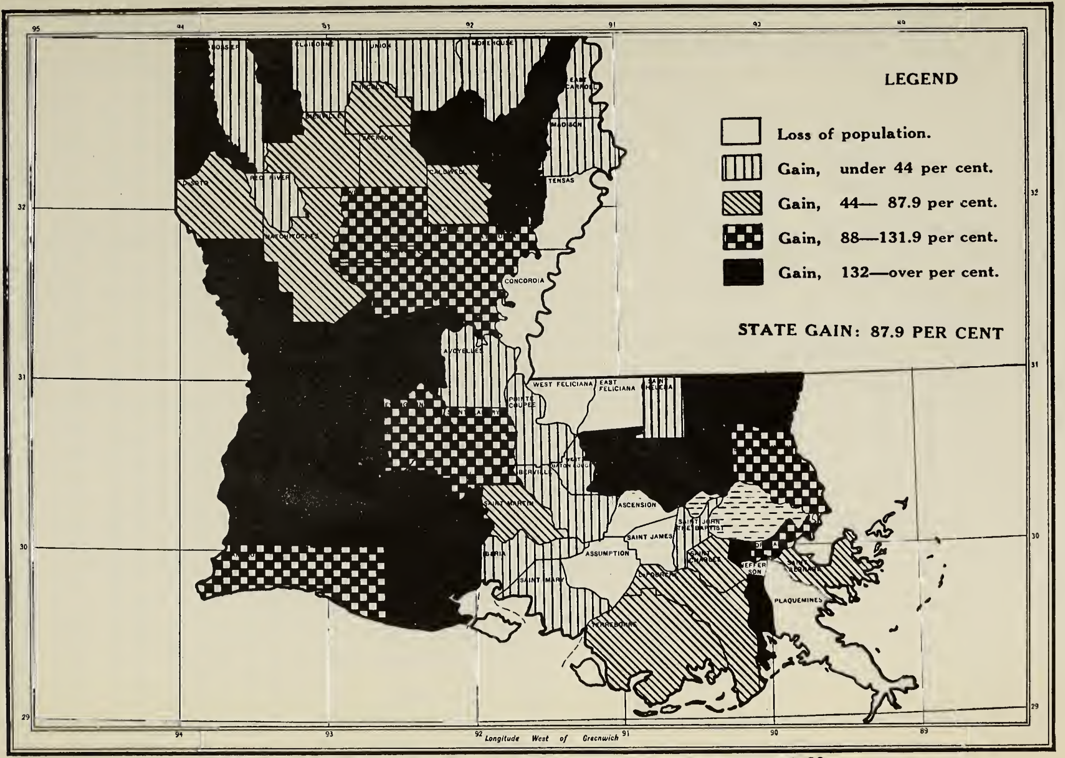

Figure 2.—Percentage Increase of Population in Louisiana, 1890 to 1930.

habitants has decreased. Data showing the changes in the population of each of the parishes are given in Table I of the Appendix. Figure 2 was constructed to depict graphically the quality and quantity of the changes which have taken place in the various sections of the Commonwealth.

The rapidity with which the nation, including Louisiana, has become urbanized in the last forty years makes it quite natural that the parishes containing cities with populations of 10,000 or over should show rapid gains in the total number of inhabitants. In addition to Orleans parish, which is co-extensive with the city of New Orleans, such parishes, are Caddo, in the northwestern part of the State; Ouachita, in the north central; Rapides, in the central; Calcasieu, in the southwest; Lafayette, in the south central; and East Baton Rouge and Washington, in that part of Louisiana lying east of the Mississippi and commonly designated, the "Florida Parishes." In addition to the speedy development and expansion of these urban centers, rapid increases of population were characteristic of four other major areas: (1) the region recently specializing in the production of small fruits (strawberries) and truck crops including the parishes of Livingston, Tangipahoa and Jefferson; (2) the section in which rice growing is the major farm enterprise embracing, in addition to Calcasieu which was mentioned among the urbanized parishes, Acadia, Allen, Jefferson Davis and Vermillion parishes; (3) a considerable area in western Louisiana centering in Beauregard, Sabine and Vernon parishes where extensive lumbering operations were carried on during the first two decades of this century; and (4) a broad expanse of territory in northeastern Louisiana, of which the parishes of Franklin, Richland and West Carroll form the core, where the break-down of large plantations into smaller farming units and the settlement of new lands have brought about an influx of farm families settling on small allotments of land.

It is important to note, however, that not all portions of the State have experienced gains in the number of inhabitants. In the rich alluvial "Sugar Bowl," population has increased very slightly, if at all. Parishes in its very heart (Ascension, Assumption and St. James) had fewer inhabitants in 1930 than in 1890. Other sugar-producing parishes gained at a rate much below that for the State as a whole. A declining or very slowly-growing population is also characteristic of the deltas of the Mississippi and Red Rivers, regions devoted almost exclusively to large plantations specializing in the production of cotton. Tensas and Concordia parishes in the delta of the Mississippi actually contained fewer people in 1930 than they did in 1890. And no parish that is classed as "Delta Cotton" gained as fast as the State as a whole. An absolute decrease in the number of inhabitants took place in East and West Feliciana parishes. It should be borne in mind that these are the only two of the State's "Upland" parishes in which large cotton plantations have prevailed, hence one suspects that these losses may be associated with the decay of the plantation system. Another area of decreasing population is Plaquemines parish adjacent to and down the river from New Orleans. This rich alluvial parish embraces the mouth of the Mississippi River.

The above considerations make it evident that some fundamental changes are taking place in the growth and distribution of the State's population and provides some basis for determining the responsible factors. Taking the entire period 1890 and 1930, it is evident that the growing of rice, fruits and vegetables, and the cutting of timber have been associated with rapid gains in population, while the production of sugar cane and the production of cotton (especially in the delta regions) have been associated with a slowly increasing or even declining population. The distribution of these enterprises in relation to soil types is such that this means that larger and larger proportions of the population have been concentrating upon the poorer soils of the State. This is clearly shown by comparing Figure 2 with Figure 3, which gives a generalized picture of the distribution of soil types in the State.

This apparent tendency for greater and greater proportions of the State's population to be concentrated on the poorer lands has very serious implications. It is of such fundamental importance to the agriculturist and agriculture that it is necessary to determine whether it applies to the rural or agricultural population, or if it is due merely to industrial and urban developments. Unfortunately, since the census reports for 1890 fail to give an enumeration of the farm population a direct comparison with 1930 on this basis cannot be made. It would be possible to compare the rural populations in 1890 and 1930, but this would also be rather invalid because many villages classed as rural at the earlier date were in the class having over 2,500 inhabitants by 1930. The best comparison seems to be that of populations living in unincorporated territory at the two dates. Therefore, these data were tabulated and comparison made. The results are presented graphically in Figure 4. It is interesting to compare the tendencies shown in this figure with those depicted in Figure 2. When only the population in unincorporated territory is taken, the losses in the "Sugar Bowl" and Delta Cotton sections embrace a larger area and thus stand out much more strikingly. At the same time, the gains in the "Hill" and "cut-over" areas are still conspicuous. Figure 4 leaves very little doubt but that there has actually been a tendency for larger and larger proportions of the State's rural agricultural population to be concentrated on the relatively poor soils found in the "hilly" and cut-over portions of the State.

It is also of importance to know about the reversals which may have occurred in the trends at various intervals during the forty-year period. It is especially necessary to consider those trends which have manifested themselves only during the last decade and may still

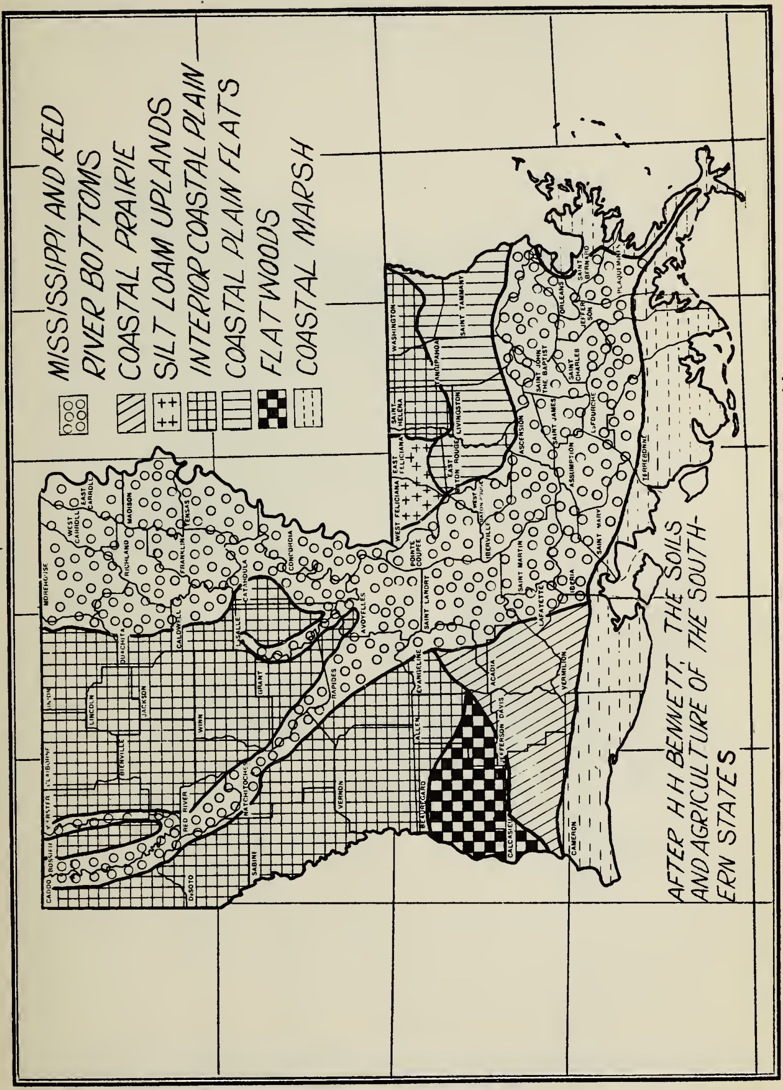

Figure 3.—Distribution of Soil Types in Louisiana.

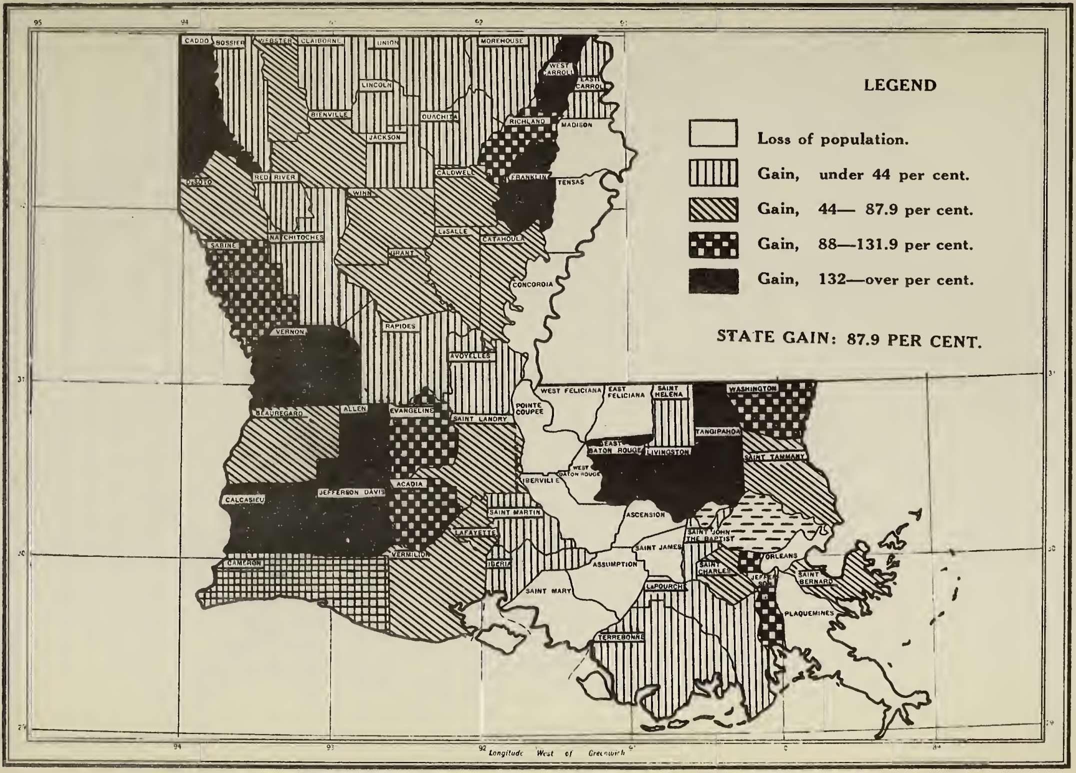

Figure 4.—Percentage Increase in the Population Living in Unincorporated Territory, Louisiana, 1890 to 1930.

be progressing in their course. Let us turn to a brief consideration of these aspects of the situation, considering first how trends for the separate decades agree with those for the period as a whole.

Changes during the three decades between 1890 and 1920 differ but slightly from those for the entire period 1890 to 1930, with two important exceptions: (1) the decadence of population in the sugar area did not set in until after 1900; and (2) the decline in the delta cotton regions was uninterrupted throughout the thirty-year period.

During the decade following 1920, however, very important reversals in trend exhibited themselves, and since these trends may not be fully spent they are especially worthy of attention. Figure 5 was prepared to present in graphic form the changes occurring during the decade 1920 to 1930. A comparison of it with Figure 2 will show how changes between 1920 and 1930 agree with those for the period as a whole. It at once becomes apparent that the regions of rapid population growth have become much more localized in the last decade than they were during the forty-year period. Among the regions where growth of population has proceeded most rapidly during the last few years the gas and oil producing and/or refining districts about New Orleans, Shreveport, Baton Rouge, Monroe and Lake Charles are conspicuous. The very rapid increase of population in the Small Fruit and Trucking regions also stand out. And also very prominent are the rapid gains in the upper-Mississippi Delta-Cotton areas where the influx of small farmers, mentioned above, has occurred.*

It should be emphasized, however, that there are also regions in which population was on the decline between 1920 and 1930. The "Sugar Bowl" and the plantation-covered Feliciana parishes are conspicuous. Large areas in western Louisiana, formerly covered with a flourishing growth of pine that furnished a basis for a prosperous lumber industry, now "cut-over," devoid of mills, and providing but a meagre subsistence to a "stranded" population were also found to have lost population rapidly during this decade. These are the same regions in which there was such a rapid influx of population during the first three decades of the period. It is also important to note that

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* For the parishes most concerned and the decade 1920 to 1930 the percentage increases in number of farm operators and land in farms is as follows:

Parish	Percentage increase in number of farm operators, 1920 to 1930		Percentage increase between 1920 and 1930 in the amount of land in farms	
	White	Colored	of White operators	of Colored operators
East Carroll	328.6	33.8	— 8.5	26.9
Franklin	63.9	8.5	—11.1	8.3
Madison	169.1	—1.6	—33.7	.9
Richland	73.9	37.4	—12.2	20.7
West Carroll	96.5	31.0	38.2	10.3

the "Upland Cotton" region, where small farms are the rule, has gained but very little during the last decade. In fact such typical upland parishes as Winn, Jackson, and DeSoto, registered a loss.

For the decade 1920 to 1930 a more detailed picture of population changes can be given. During this period records are available which permit comparisons to be made for smaller units than the parish. Changes in the population of each minor civil division (ward) in the State were calculated and are presented in Figure 6 which shows the percentage increase of population in the wards which gained, and Figure 7 which shows the percentage decrease in the wards which lost population.

The trend in population residing outside of incorporated centers during the decade 1920 to 1930 is both interesting and important. The percentage increases for all of the parishes were calculated, and Figure 8 was prepared to summarize the changes. The same scale was used as in Figure 5 to facilitate comparisons. In this case again, trends revealed in the population as a whole, show up in a more pronounced manner among the population of the unincorporated territory.

POPULATION INCREASE AND RACE

After this brief description and discussion of the portions of the State in which gains and losses have occurred, we may now turn to the comparative increases of the races within the State. Whites and negroes, the two major races represented in Louisiana, show very marked differences in their rates of increase. The more rapid gains have been confined to the white population, and they have operated progressively to increase the relative importance of this element in the population. On the other hand, the colored portions of the population have consistently become of less relative importance. This is brought out very clearly in Figure 9 in which the growth of the white and negro populations of Louisiana from 1810 to 1930 is charted. It is important to observe that in 1890 white people and negroes were nearly equal in number, although throughout most of the Nineteenth Century the negro population of the State exceeded the white. The census of 1890 enumerated 558,395 white people and 559,193 negroes in the State. In the course of the next forty years the white population increased 136.1 per cent, so that by 1930 they numbered 1, 318,160 and constituted 62.8 per cent of the total population. As compared to this during the same period, the negro population increased only 38.8 per cent, so that by 1930 they numbered but 776,326 and constituted only 36.9 per cent of the State's population. Perhaps the comparative increases would be comprehended better if it is stated that there were 100 negroes to every 100 white people in 1890, while by 1930 there were only 59 negroes to every 100 white persons.

There appears to have been no regularity in the comparative

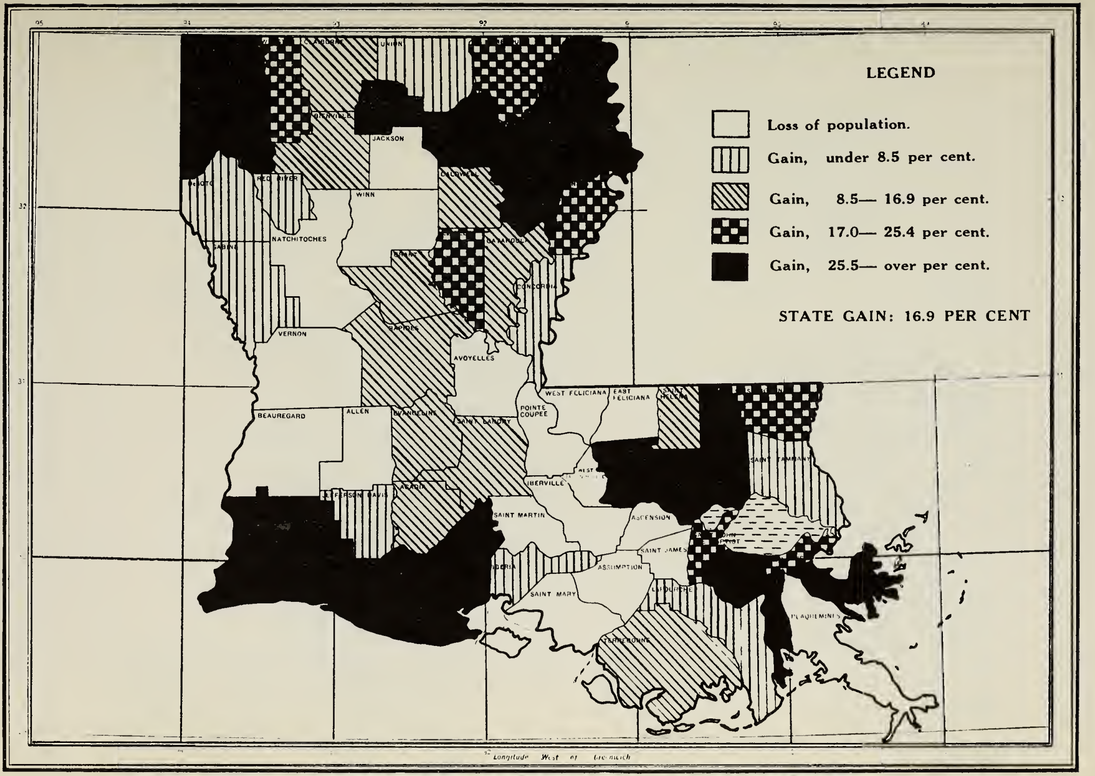

Figure 5.—Percentage Increase of Population in Louisiana, 1920 to 1930.

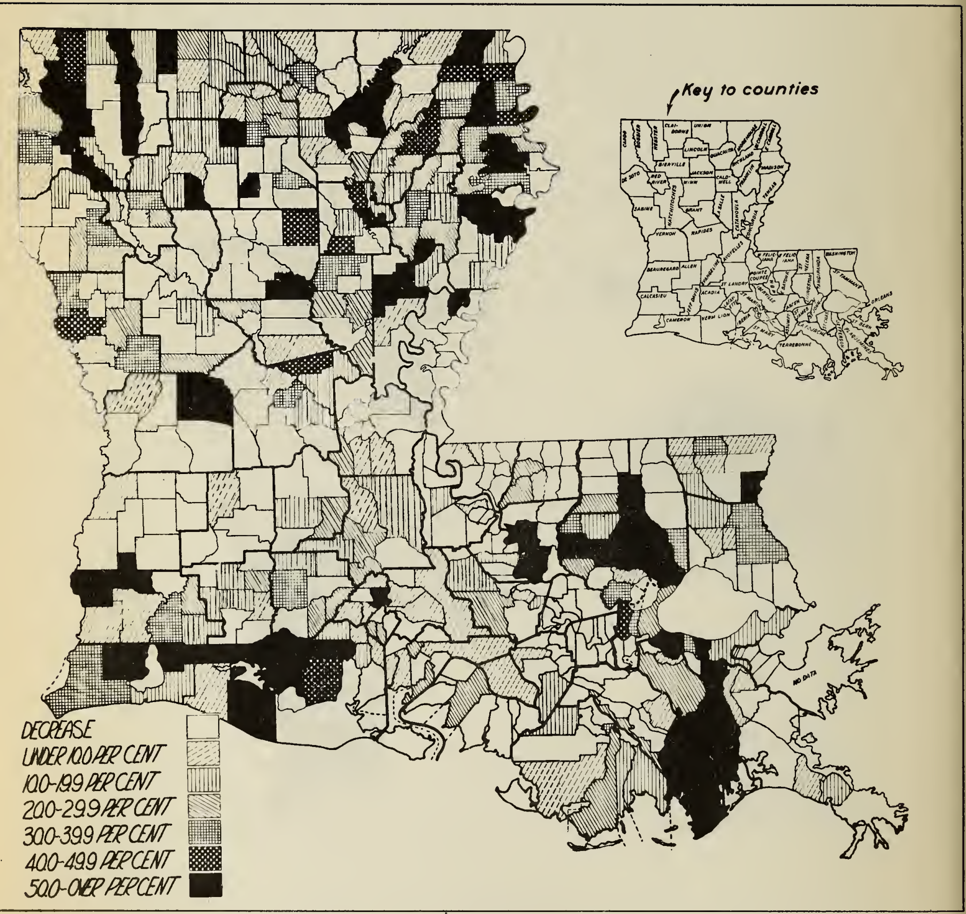

Figure 6.—Percentage Increase of Population by Wards, 1920 to 1930.

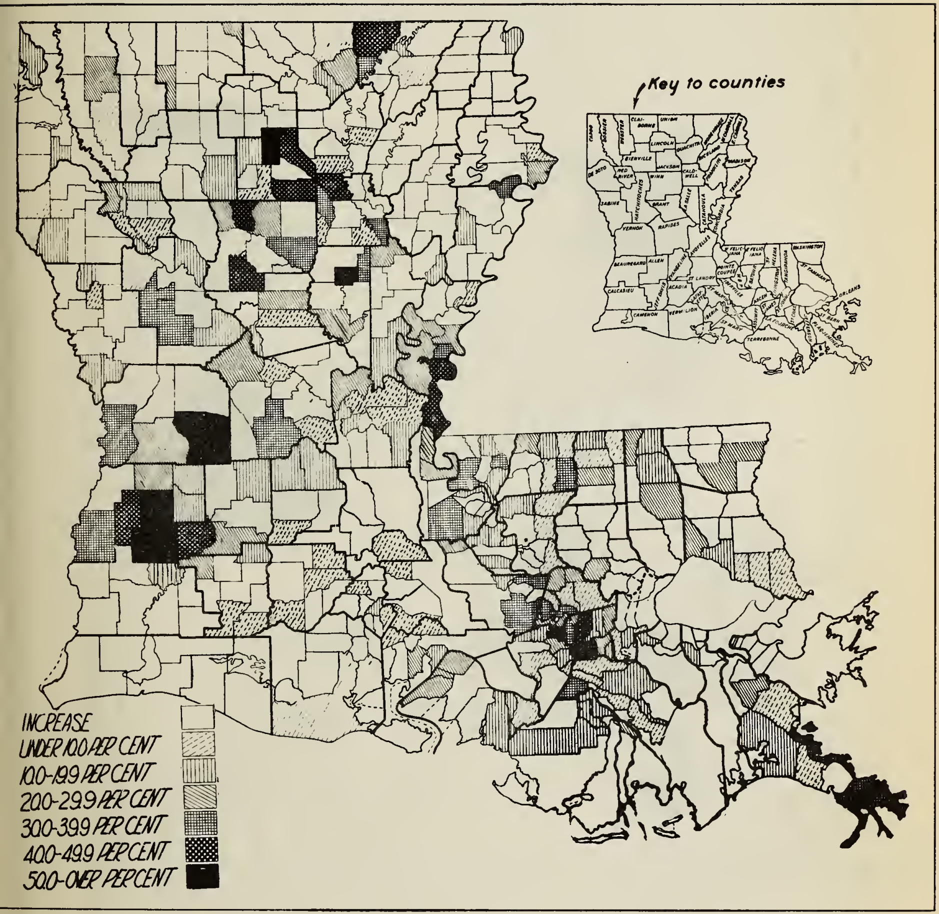

Figure 7.—Percentage Decrease of Population by Wards, 1920 to 1930.

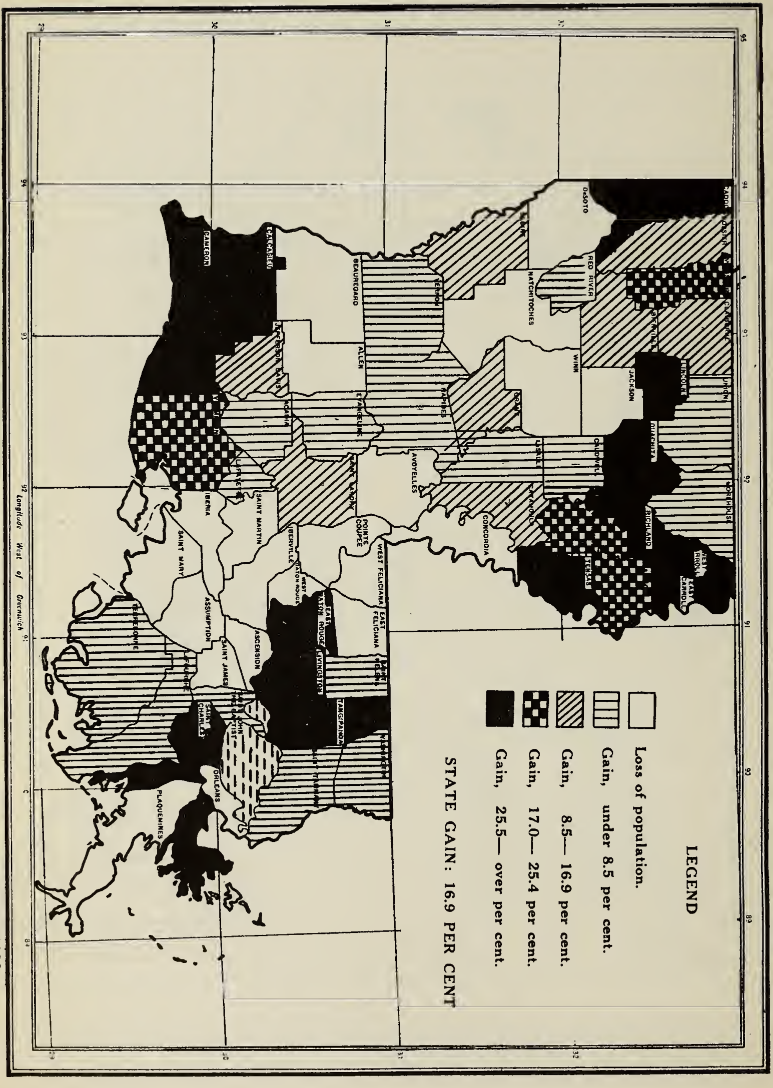

Figure 8.—Percentage Increase of Population Residing Outside Incorporated Centers, Louisiana, 1920 to 1930.

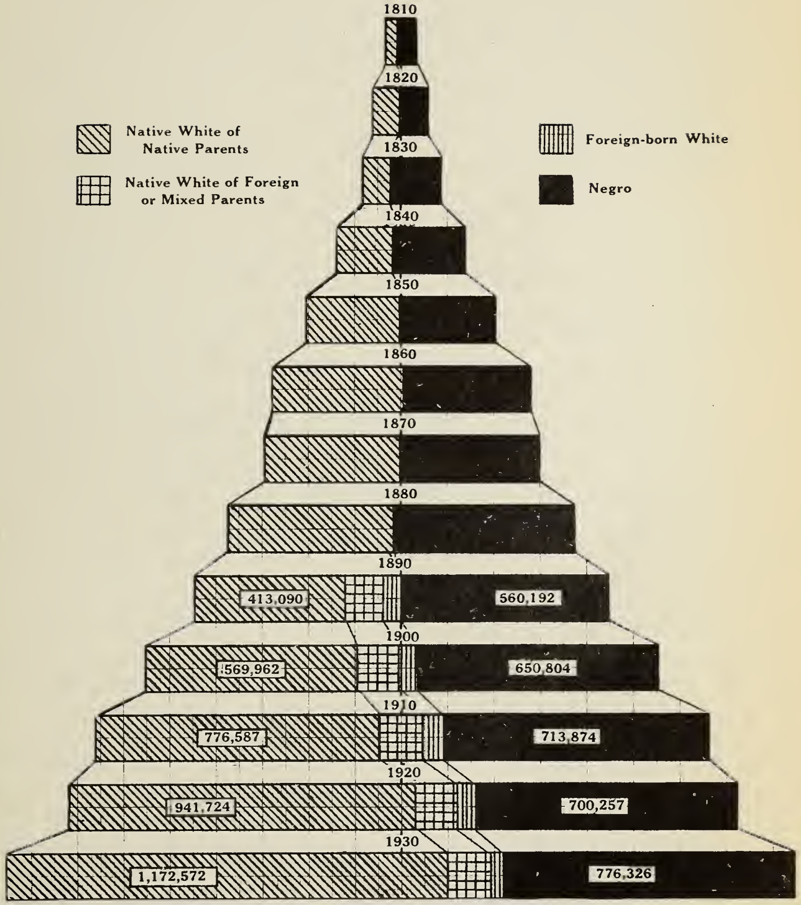

Figure 9.—Growth of Population in Louisiana 1810 to 1930.

rates at which the population increased from decade to decade except that the rate among the white population was always above that among the negro. For example, in the decade preceding 1900 the white population increased very rapidly, gaining 30.7 per cent, a rate almost double the gain of 16.4 per cent registered by the negro population. Again in the decade 1900 to 1910 white population increased rapidly, gaining 29.0 per cent. Among negroes, however, during this decade a heavy tide of migration to Northern cities set in which held their increase within the State down to 9.7 per cent. The period of the World War saw a rapid falling off in the rate of increase among the white population. Thus during the decade 1910-1920 their percentage gain was only 16.5 or about one-half of what it had previously been. But, in the meantime, the exodus of negroes to Northern industrial centers was actually so great as to exceed their natural increase and bring about a loss of 1.9 per cent in the negro population. During the post-war decade, 1920 to 1930, both the white and negro population increased, the former gaining 20.2 and the latter 10.9 per cent. The increases of the two races were a third slower than between 1890 and 1900, but again the rate among the white population was approximately double that of the negro.

Members of all other races, mostly Indians and (in 1930) Mexicans, numbered only 999 in 1890 and 7,107 in 1930. To be strictly consistent, the 4,552 Mexicans enumerated in 1930 should be classed with the white population as they were in all censuses taken previously to 1930. However, these elements are so sparsely represented in the State as to warrant little attention; the important races being the white and the negro.

These changes in the relative importance of the white and negro races were not confined to a few areas. They were exhibited in practically every part of the State and among every important division of the population. Thus, for example, in 52 of the 64 parishes in the State, negroes composed smaller proportions of the population in 1930 than they did in 1890. The major exceptions were in the rice-producing areas in the southwestern part of the State. For instance, in this section the negroes of Acadia parish increased from 1,629 to 8,103. This rate was so much greater than that of the white population of this parish that the per cent of negroes in the population rose from 12.3 in 1890 to 21.6 in 1920, falling back slightly to 20.6 in 1930. Again in the four parishes, Allen, Beauregard, Calcasieu and Jefferson Davis, (all formed in 1913 from the old Calcasieu parish) negroes increased so much more rapidly than whites that whereas they made up 15.9 per cent of the population in 1890, by 1920 the corresponding percentage was 28.6, remaining high (26.6) in 1930. In Vernon parish the negro population also increased much more rapidly than the white. So much so that the proportion of negroes in the total population of the parish increased from 9.1 per cent in 1890 to 24.9 in 1920. However, in this parish, the corresponding percentage fell back to 17.9 per cent by 1930. Negroes also increased much faster than did the white population in the urban parish of Orleans. The relative gain was great enough to advance their proportion of the total population from 26.6 per cent in 1890 to 28.3 per cent in 1930. Similar tendencies were present in the pine-covered parishes of Washington and Winn, where negroes increased from 30.8 to 32.5 per cent of the population in Washington and from 14.3 to 25.0 per cent of the population in Winn. In the lumbering and truck farming parish of Livingston, they increased from 15.1 per cent to 22.8. In Bienville and Lincoln parishes they practically held their own, increasing from 44.4 to 44.7 in the former, and in the latter, although decreasing from 42.5 in 1890 to 37.2 in 1920, again constituting 42.5 per cent of the population in 1930.

The relative gain among white people and loss among negroes was evidenced in four of the State's five "type-of-farming-areas." It is very significant that the losses were most pronounced in the "Cane" and "Delta Cotton" areas, both of which are characterized by large plantations and dependence upon negro labor. The decline in the Cane area, in which we include eleven parishes, was absolute as well as relative, the number of negroes decreasing from 108,111 in 1890 to 92,816 in 1930, a loss of 14.1 per cent. This caused the percentage that negroes comprised of the total population to drop from 54.6 where it stood in 1890 to only 37.7 in 1930. Although no actual decrease in numbers took place in the Delta Cotton area, the gain in the number of negroes of 26.3 per cent during the forty years was very much less than the total gain in the population of the area (90.7 per cent). Because of this, negroes who made up nearly three-fourths (71.4 per cent) of the population of this area in 1890, constituted less than one-half of the population (only 47.3 per cent) in 1930. In the "Upland Cotton" and "Fruits and Vegetables" areas the negro, while increasing slightly in absolute numbers, lost in relative importance because the white population was increasing so much more rapidly. Thus in the rolling upland regions where small cotton farms are the rule, the number of negroes increased 46.4 per cent between 1890 and 1930. But in the meantime, the white population of the same regions increased 148.3 per cent, so that the percentage negroes constituted of the total population dropped from 53.4 to 40.2. And in the Small Fruit and Trucking regions where negroes increased by 45.8 per cent, white people gained at more than six times this rate (204.9 per cent), causing the percentage of negroes in the total population to fall from 46.3 to 29.2 per cent.

On the other hand, in the "Rice" area where negroes had previously been very few (they constituted only 16.2 per cent of the population in the area in 1890) a very different tendency occurred. In this region, the rate of increase among negroes exceeded that of the white population. During the period 1890 to 1930 the number of negroes increased from 6,975 to 33,710, a gain of 383.3 per cent.

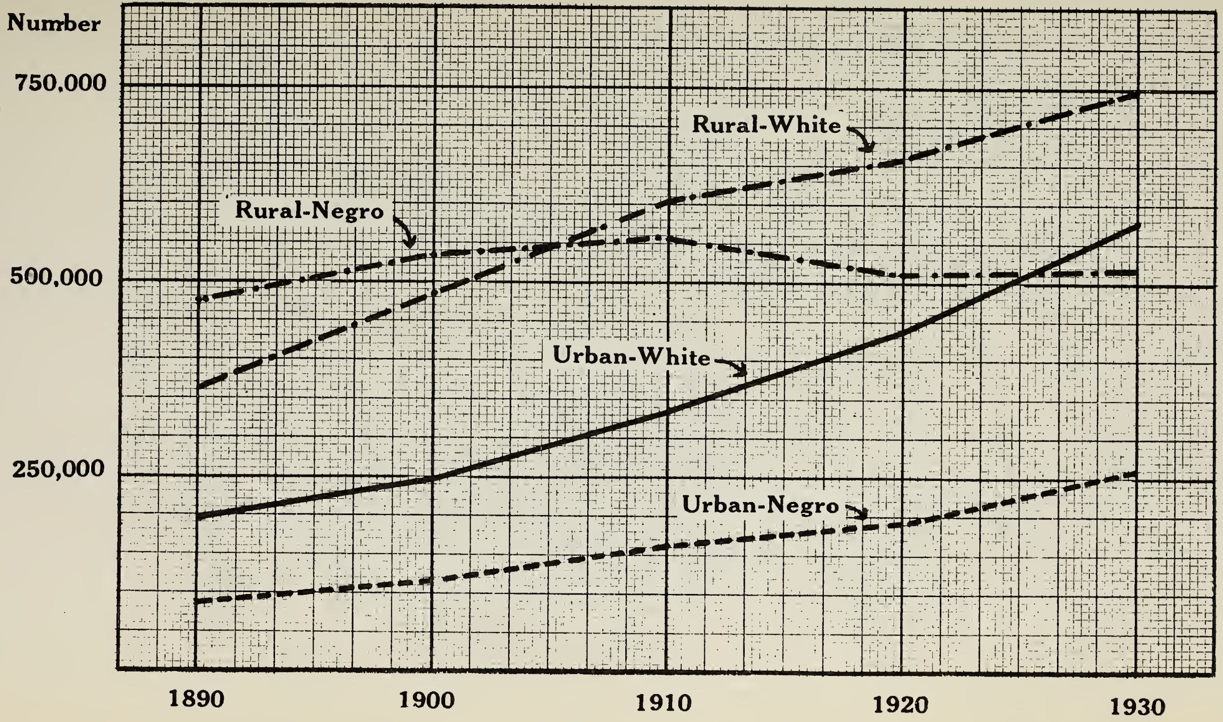

Figure 10.—Growth of White and Negro Populations in the Urban and Rural Portions of the State, 1890 to 1930.

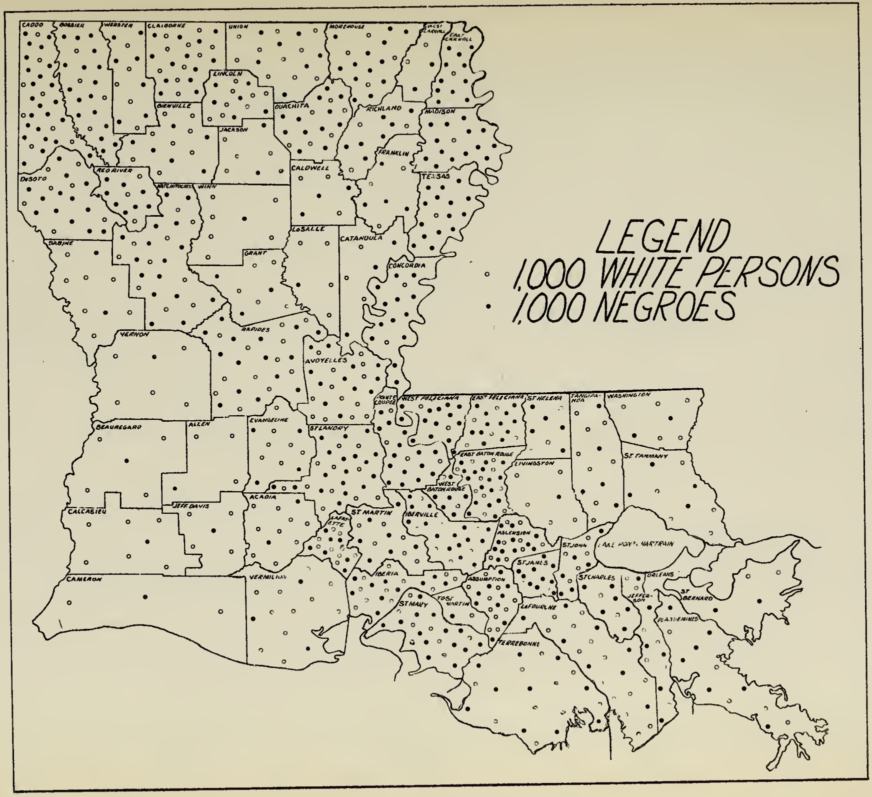

Figure 11.—Distribution of the White and Negro Populations of Louisiana, 1890.

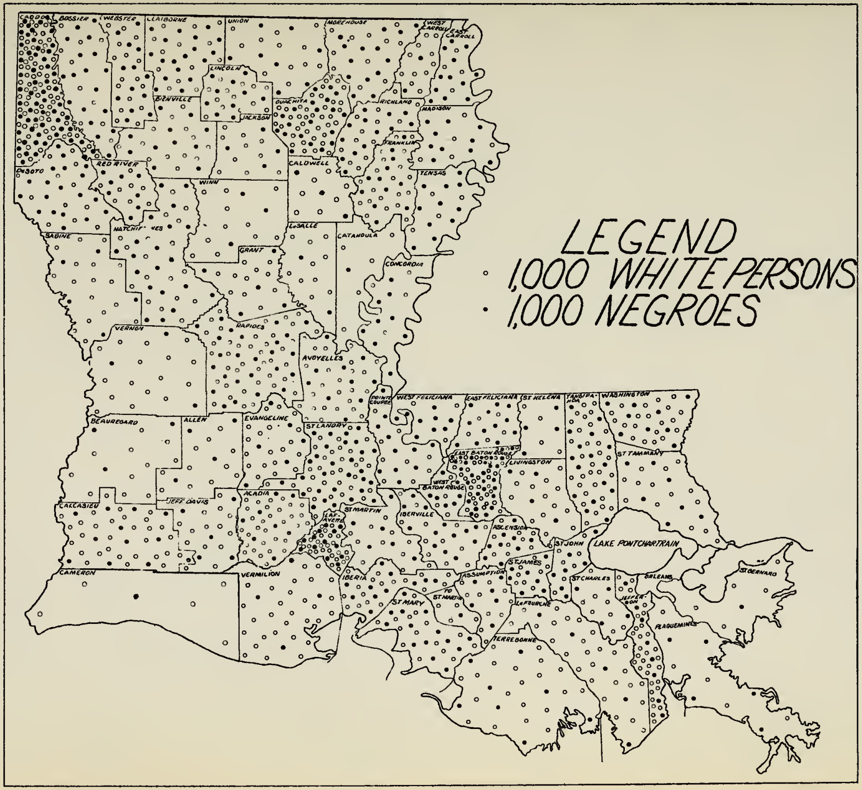

Figure 12.—Distribution of the White and Negro Populations of Louisiana, 1930.

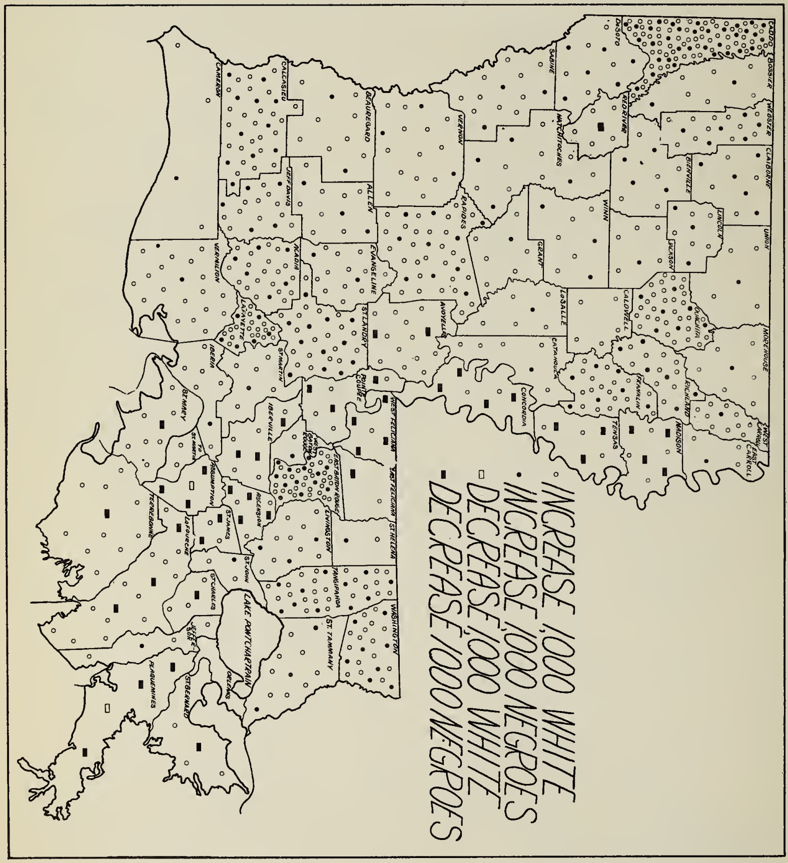

Figure 13.—Distribution of the Increases and Decreases in the White and Negro Populations of Louisiana, 1890 to 1930.

And although the corresponding increase among white people was also very rapid, amounting to 222.9 per cent, it was not sufficient to keep the proportion of negroes in the population from mounting to 22.5 per cent of the total by 1930.

The comparative rates at which whites and negroes have increased in the urban and rural areas of the State are most interesting and significant. Stress should be laid upon the fact previously mentioned, that the negro population of New Orleans has been increasing faster both absolutely and relatively than the white population of the city. This brings to the fore the problem of the relative increase of the two races in rural and urban areas. And an investigation of this problem reveals some very significant facts. To assist in visualizing the situation, the important features concerning the trends in population growth for both races in rural and urban areas are charted in Figure 10. From this graph it is evident that the relative increase in the importance of white people in the population of the State is entirely due to the changes which have occurred in the rural districts. In the urban portions of the State, negroes have held their own. Indeed, the negro population of urban districts increased somewhat faster than the white. Thus between 1890 and 1930 the white population residing in urban areas increased from 196,541 to 574,249, a gain of 192 per cent; but in the meantime the urban negro population increased from 87,094 to 257,463 which represents a gain of 196 per cent. During the same period (1890 to 1930) in the rural districts, the white population increased from 361,854 to 754,911. This was accompanied by a gain in the negro population from 472,099 to 518,863. On a percentage basis, a gain of 106 per cent in the rural white population took place as compared with 10 per cent in the rural negro population. The significance of the comparative increases of whites and negroes is brought out more clearly by the following ratios. In urban districts, which in 1890 contained only 44 negroes for every 100 white people, the ratio was slightly higher in 1930, being 45 negroes per 100 white persons. In sharp contrast to this are the ratios for rural districts. In these areas the negro population exceeded the white in the ratio of 131 negroes for every 100 white persons in 1890, but the relative increases of the two races were such that there were only 70 negroes to every 100 white people by 1930.

The above data make it very clear that there has been a tendency towards a more equal distribution of the two races throughout the urban and rural portions of the State. This is further shown by comparing the percentages which negroes constituted of the total population at the two dates. For example in the urban districts negroes made up the same proportion of the population (30.6 per cent) in both 1890 and 1930. But in the rural districts, where they constituted 56.6 per cent of the population in 1890, by 1930 the corresponding percentage was only 40.9.

The tendency for the rate of increase among urban negroes to exceed that among the white population of urban centers was exhibited in three out of the four decades between 1890 and 1930: from 1890 to 1900 the percentage increases for urban negroes and whites were 34.3 and 26.6; between 1900 and 1910 the corresponding percentage increases were 37.5 and 34.7; and in the decade 1920 to 1930 the percentage increases were 35.2 and 31.3 for urban negroes and whites, respectively. However, during the era when the northern migration of negroes was most intense (1910-1920), the percentage increase of urban whites (30.4) exceeded that of urban negroes (18.4). This indicates how deeply this migration cut into the negro population of the State.

But in this respect also, trends in rural districts were quite different from those in the urban. Between 1890 and 1900 the percentage increase of the rural white population amounted to 32.9. This was considerably above the rate of increase among the white population of urban centers and was nearly as high as that among urban negroes. Following 1900, however, the percentage increase of the white population in rural districts slowed down materially, falling to 26.0 during the decade 1900-1910 and to the extreme low of 8.8 between 1910 and 1920. However, a slight recovery to 12.8 was made in the decade from 1920 to 1930. Comparable data for rural negroes show a gain of 13.1 per cent between 1890 to 1900; in the next decade also a slight gain of 3.6 per cent took place; but between 1910 and 1920 the negro population residing in rural districts lost 7.8 per cent in number. A slight gain (1.8 per cent) between 1920 and 1930 did little to offset this. It is interesting to note that the total rural negro population in Louisiana reached its maximum of 553,029 in 1910. It has not approached this peak since. Far from attaining the high point of 1910, there were, in fact, about 15,000 fewer negroes in the rural portions of the State in 1930 than there were in 1900, the figures being 518,863 and 533,850, respectively.

As indicated above, there seems to have been, during the 40 year interval 1890 to 1930, a tendency for the proportions of whites and negroes in the various sections of the State to become more equal. It seems that increase or decrease of negroes in the population of a given area is definitely related to their relative importance in that area in 1890. The tendency appears to have been for them to increase in regions where they were previously scarce and decrease in the parishes in which they were formerly found in the largest proportions. (See Figures, 11, 12 and 13.) Thus in 1890 the percentage of negroes in the total population of the parish ranged from 9.1 in Vernon parish to 93.4 in Madison. (See Table I of the Appendix.) In addition to Vernon, the parishes of Acadia, Calcasieu, Jefferson Davis and Winn all contained less than 15 per cent negroes. And in addition to Madison, the populations of Concordia, East Carroll, Tensas and West Feliciana parishes were all composed

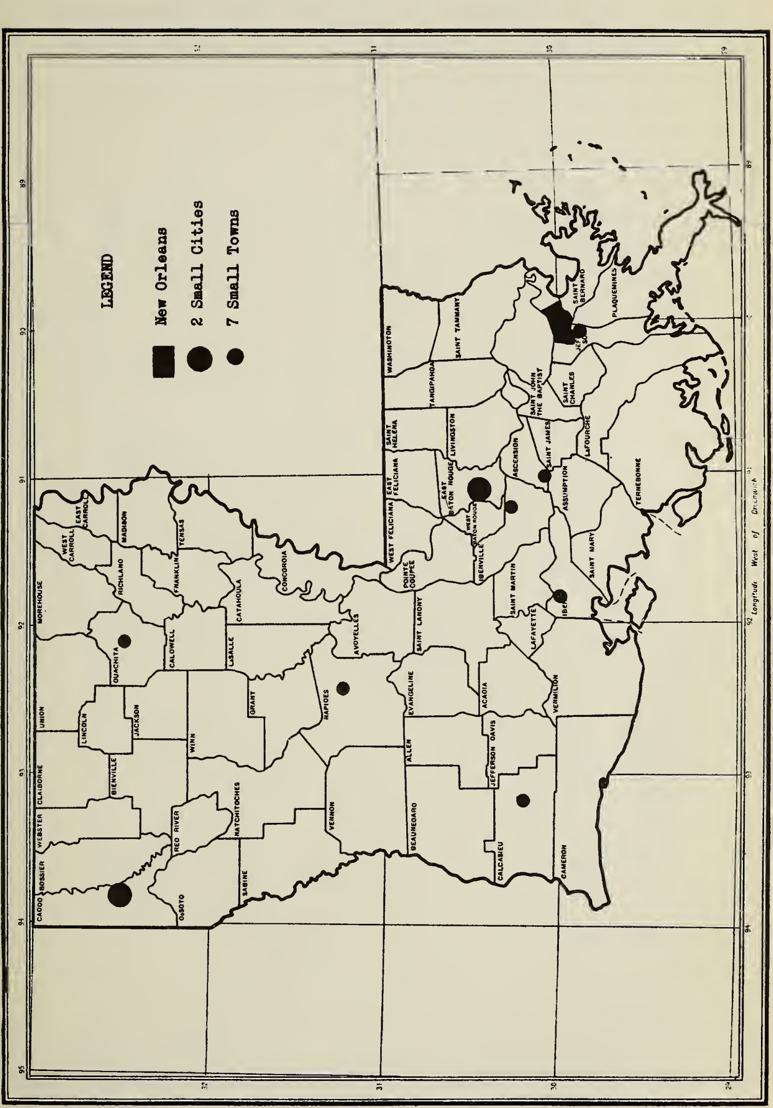

Figure 14.—Distribution of Urban Centers in Louisiana, 1890.

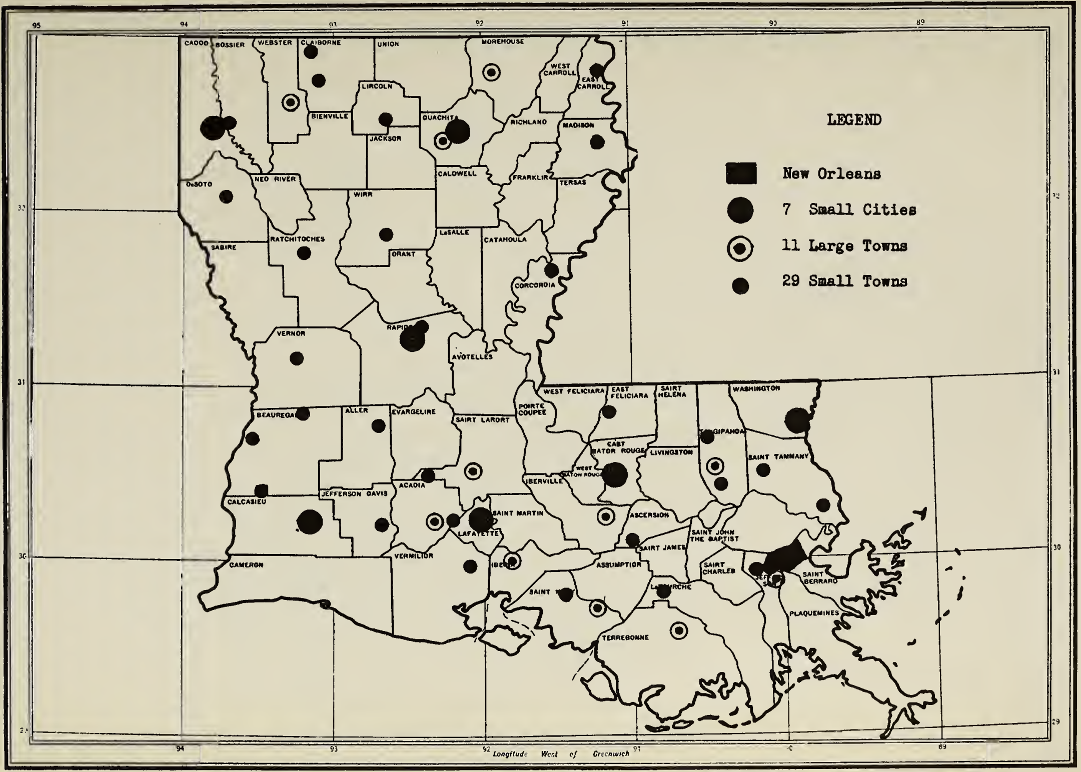

Figure 15.—Distribution of Urban Centers in Louisiana, 1930.

of 80 per cent, or more, negroes. By 1930, however, the range had narrowed, a percentage of 9.5 negroes in Cameron being the lower limit, and 76.4 per cent in West Feliciana being the upper; and Vermilion was the only other parish that contained less than 15 per cent negroes. No parish, of course, had as high as 80 per cent, but in East Carroll, Tensas and Concordia (all in the Mississippi delta) negroes constituted more than 70 per cent of the population. The narrowing of the range of course indicates a tendency towards a more uniform distribution of the races in the various parts of the State. This tendency is further shown by the fact that of the eleven parishes in which negroes increased in relative importance, only Bienville contained more than 40 per cent negroes in 1890, while of the fifty-two parishes in which negroes decreased in relative importance, only 4 (Cameron, LaSalle, Sabine and Vermilion) contained less than 40 per cent negroes in 1890.

INCREASE OF POPULATION AND URBANITY

Perhaps the rapid development of an urban population in recent years has been the most striking change in Louisiana's population. It seems fair to say that in 1890 the State consisted of one large city and a large rural hinterland. At the end of the Ninteenth and the beginning of the Twentieth centuries, small cities and towns were almost totally lacking in the State. This is brought out in a striking manner by Figure 14. To give specific data, in 1890 only 25.4 per cent of the State's population was classed as urban. And 86 per cent of this urban population resided within the city limits of New Orleans. Besides New Orleans there were in the entire State only nine other centers containing as many as 2,500 inhabitants (the conventional line of demarcation between rural and urban). And of the nine, only Shreveport with 11,979 inhabitants and Baton Rouge with a population of 10,478 came in the class having 10,000 or more inhabitants, thus qualifying for the designation of "small cities."

The situation in 1930 was quite different. See Figure 15. Two people out of every five in the State (39.7 per cent) lived in urban centers; and only 55 per cent of this urban population was resident in New Orleans. Shreveport had sprung ahead rapidly and by 1930 contained 76,655 inhabitants. The population of Baton Rouge had increased to 30,729. In addition to these Alexandria, Bogalusa, Lafayette, Lake Charles and Monroe had by this time grown into the small city class, all containing more than 10,000 inhabitants. Furthermore by 1930 there were in the State forty other centers large enough to be classed as urban. The distribution of these urban centers is an important consideration. It should be noted that in 1890 urban centers were present in only ten of the State's parishes. Their location is given in Figure 14. During the forty-year interval urban nuclei made their appearance in 26 additional parishes (as may be seen by a comparison of Figure 15 with Figure 14) so that by 1930 more than half of the State's parishes contained a center having 2,500 or more inhabitants. Thus to a considerable extent by 1930 the great void which formerly existed between a large commercial and industrial center and the population of a strictly rural hinterland had been filled with numerous small cities, towns and villages.

In evaluating these changes it is important to know that the rate at which the urban population grew was nearly four times the rate of increase in rural districts. Thus the urban gain was 194 per cent as compared with 52 per cent in the rural. This is reflected in the relative proportions of the rural and urban classes in the population. Whereas in 1890 there were only 34 urban to every 100 rural people, by 1930 the corresponding ratio was 66 to 100.

The percentage increases, according to the size of center, throw further illumination upon the subject. In the period 1890 to 1930, New Orleans, the only city with over 100,000 inhabitants, gained 90 per cent in population. This is just slightly higher than the increase for the State as a whole, which was 87.9 per cent. Small cities (10,000—100,000) showed an increase of 533 per cent in number of inhabitants. In 1890 there were no large towns (5,000—10,000) in the State, while by 1930 places in this category contained 72,564 inhabitants. Many small towns (those centers containing between 2,500 and 5,000 people) grew into large towns or small cities during the forty-year period, but this depletion in the ranks was more than offset by the advancement of villages into this class, so that the total population residing in such centers increased by 424 per cent.

Even within the rural population there was a tendency for the number of people residing in the incorporated non-agricultural areas to increase faster than the number residing in the unincorporated agricultural portions. Thus the population in unincorporated territory numbered 786,119 in 1890 and had increased to 1,134,007 by 1930, a gain of only 44 per cent. While during the same period the inhabitants of large villages (1,000—2,500) increased from 23,689 to 78,415, a gain of 231 per cent, and the inhabitants of small villages (those under 1,000 in population) increased from 24,935 to 55,639, a gain of 123 per cent. Whereas in 1890 only 5.8 per cent of the rural population resided in incorporated centers, by 1930 the corresponding percentage was 10.6. These data, pertaining to the growth of population in centers of various sizes and in the unincorporated territory of the State for the period 1850 to 1930, were summarized and are shown graphically in Figure 16.

For the decade 1920 to 1930 a more detailed analysis of this urbanward trend is possible. Omitting St. Bernard parish, which was redistricted between 1920 and 1930, the 521 wards in the State were grouped on the basis of the largest center they contained or of which they comprised a portion. The direction and amount of change in population was then noted. The results are presented in Table I.

It is most evident that gain in population increases as the size of the center increases.

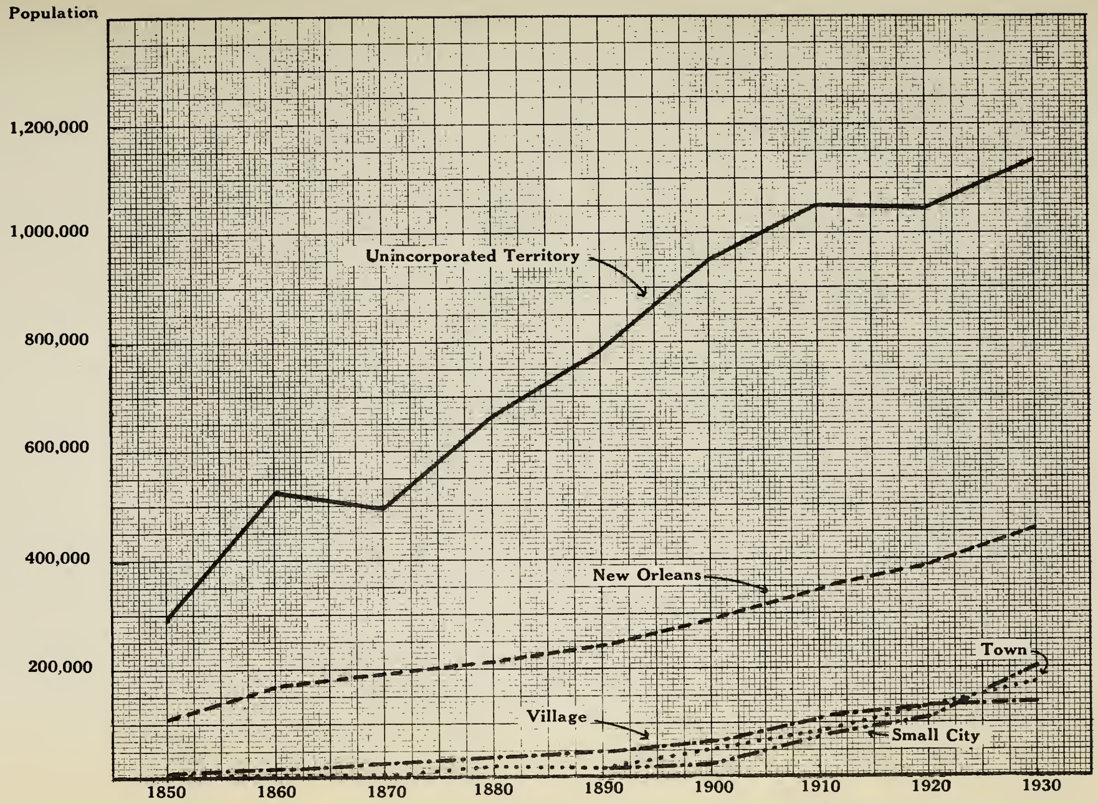

Figure 16.—The Growth of Population 1850 to 1930 in Incorporated Centers of Various Sizes and in the Unincorporated Territory of the State.

Table 1. Relationship Between the Size of the Largest Center a Ward Contains or Forms Part of and the Increase of Population, 1920 to 1930.

Size of Center	Number of Wards			Aggregate Population			
	Total	Gaining	Losing	1920	1930	Gain	Percentage Gain
Large City	17	17	0	387,219	458,762	71,543	19.0
Small City	10	10	0	149,985	238,341	88,356	58.8
Large Town	15	13	2	89,027	123,355	34,328	38.5
Small Town	29	25	4	154,030	192,253	38,493	25.0
Large Village	54	36	18	217,525	242,658	25,133	11.5
Small Village	90	51	39	258,522	265,383	6,861	2.7
Unincorporated	306	151	155	537,233	574,059	36,826	6.4
Total	521*	303	218	1,793,541	2,095,081	301,540	16.8

* Does not include the Parish of St. Bernard which was redistricted between 1920 and 1930.

But, as is well known, the corporate limits of a city or town may not contain all the urban or industrial population of the center. The rapid increase of the urban population in the State is seen also in the tendency of those unincorporated territories contiguous to urban centers to gain more rapidly than the more remote unincorporated areas. A simple tabulation demonstrates this for Louisiana: parishes were first classified into five groups according to the size of their largest incorporated center. After the classification had been made, the percentages by which the population in the unincorporated portions of each had increased between 1890 and 1930 were calculated. The results were as follows: in unincorporated territority of the ten "small-village" parishes a gain of 12.9 per cent took place; the gain in the unincorporated portions of 18 "large-village" parishes was 48.3 per cent; in 18 "small-town" parishes, the population residing in unincorporated territory gained 29.6 per cent; the population residing in the unincorporated portions of 10 "large-town" parishes gained 46.8 per cent; and in the seven "small-city" parishes a gain of 96.8 per cent was made in the population of the unincorporated portions.

The data given above leave little doubt that changes have tended to concentrate the population, not only into urban centers, but also into the regions immediately surrounding such centers. Figure 6 which shows the degree by which the population of each minor civil division (ward) in the State gained in the decade 1920 to 1930 should be studied in this connection. And Figure 17 showing the changes between 1920 and 1930 in the population in the unincorporated portions of each ward gives additional enlightening information on this subject.

The growth of the urban population has not been sporadic but has proceeded at a very uniform pace. For example the percentage increases for the four decades 1890 to 1930 were very uniform, being 29.0, 35.6, 26.5 and 32.7, respectively. These regular increments are in sharp contrast to the tendencies in the rural areas during the corresponding decades. Here the increases were less, of course, and also more variable. Gains of 21.6, 14.2, .9 and 8.3 per cent were made in the four decades 1890 to 1930. These data exhibit in striking fashion the uniform, progressive manner in which urbanization has been taking place regardless of the variations in rural districts.

As indicated when discussing the comparative increase of population according to race, the very rapid increase of urban population was true for both whites and negroes. Some additional details may now be given. In the first place the rapidity of increase in urban districts was greater in the case of negroes than of whites. To be specific, in 1890 the negro population of the State was found almost entirely in rural sections. Only 87,094 persons or 15.6 per cent of the negro population was reported as living in centers of 2,500 or

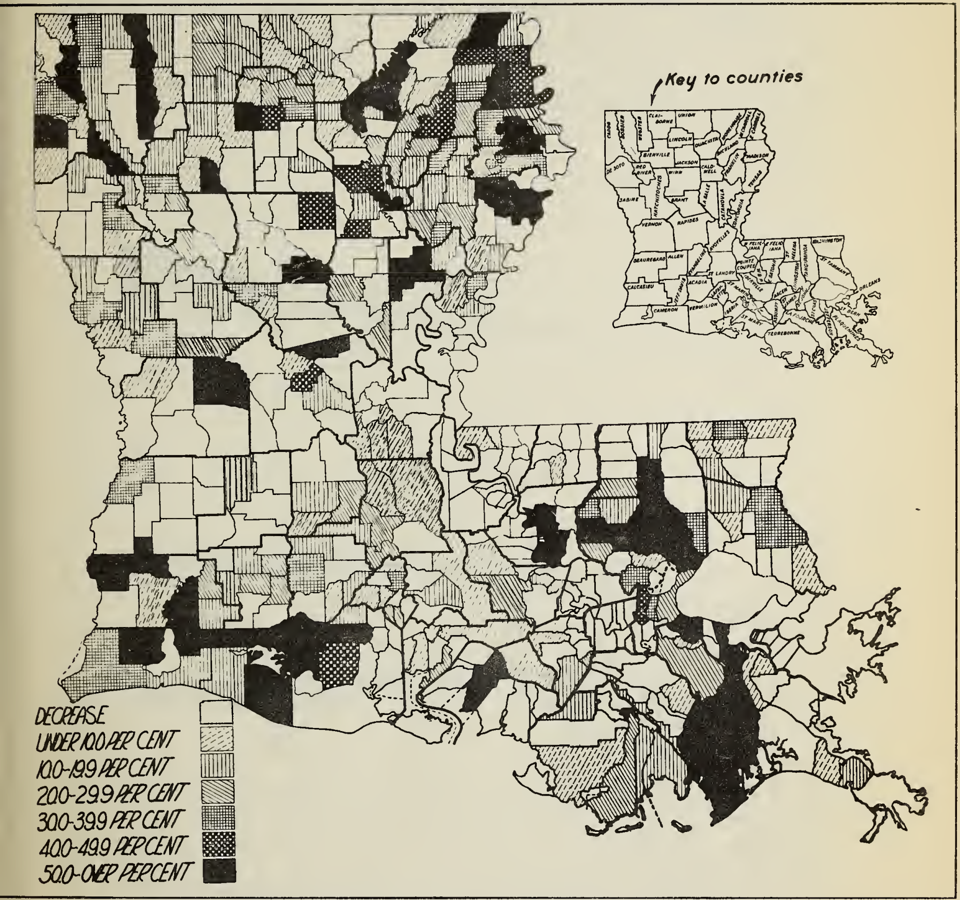

Figure 17.—Percentage Increases in the Population Living Outside Incorporated Centers by Wards, 1920 to 1930.

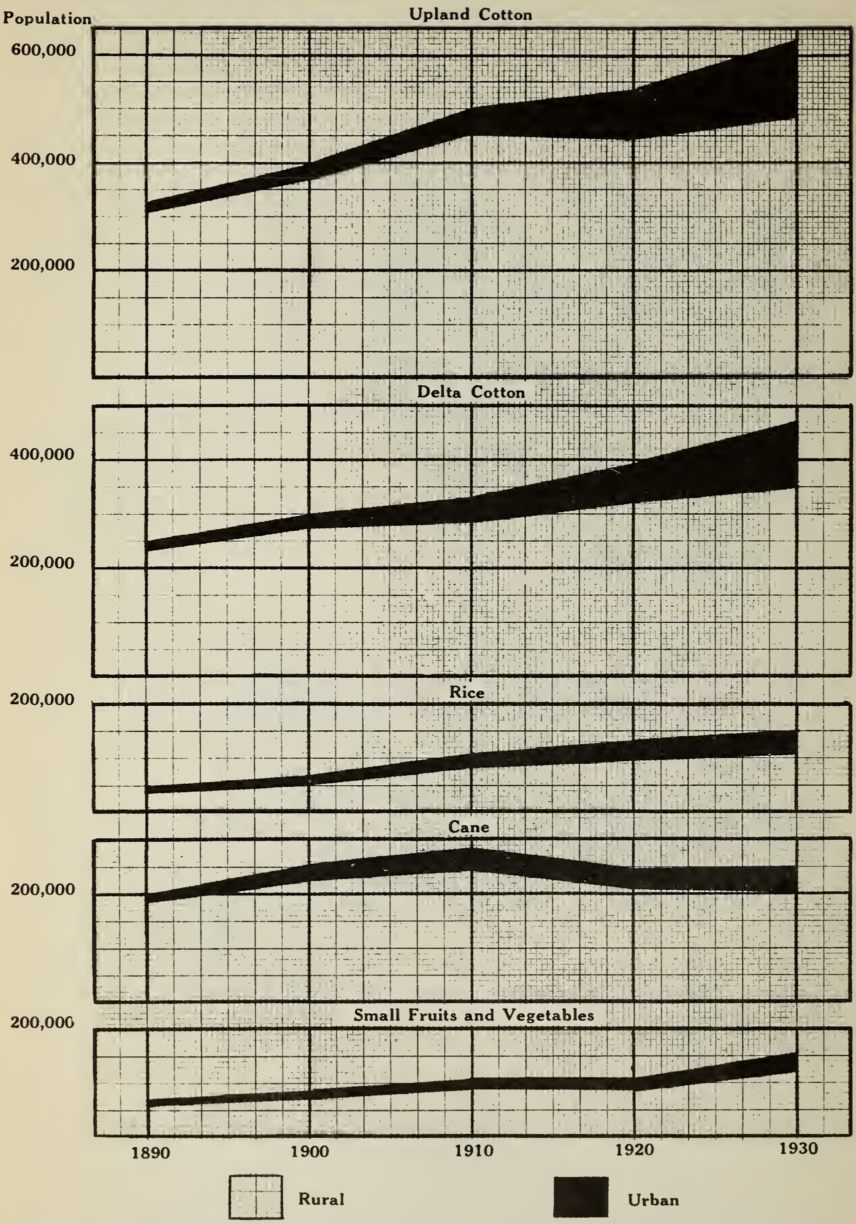

Figure 18.—Growth of Rural and Urban Populations in Each Type-of-Farming Area, 1890 to 1930.

over. Of these, 64,491 or 74 per cent were in New Orleans, leaving only 22,603 negroes in the remaining urban centers of the State. However, after 1890 the proportion of the negro population residing in urban centers mounted rapidly, being 18.0 in 1900, 22.5 in 1910, 27.2 in 1920, and 33.2 in 1930. At the latter date, 257,463 negroes were reported as residents of urban centers, and of these only 129,632 or 48 per cent were in New Orleans.

As compared with these gains among the negro population only 35.6 per cent of the white population, or 196,541 persons, were residents of urban centers in 1890. This percentage remained at 35.6 in 1910, rising to 39.9 in 1920 and 43.6 in 1930, when 574,249 white persons were residing in urban centers. Thus despite the fact that the white population of the State was growing much more rapidly than the negro, as we have already shown, if only the urban population is considered, the negro population has made the more rapid gain. The percentage increases in urban population over the forty-year period were 192 for whites and 196 for negroes. Furthermore, the date which were presented above showed that each decade except 1910 to 1920 the percentage increase of the urban negro population exceeded that of the urban white. These data all emphasize the rapidity with which the negro population has been congregating in the urban portions of the State. In 1890 they lagged far behind, but so fast was their increase, that by 1930 they were residents of urban centers in nearly as large proportions as were persons of the white race.

That the urbanward trend embraced the entire state, seems evident from the appearance of new urban nuclei in so many additional parishes. It is also evidenced by the fact that it was characteristic of all five of the type-of-farming areas. Data showing the comparative gains in the rural and urban populations of each of the type-of-farming areas were assembled and are presented in Table II. Since the trends in the white and negro populations were so different, the data also have been sub-divided according to race. From this table, and from Figure 18 which shows the growth of rural and urban populations in each type-of-farming area, it is most apparent that urban gains have greatly exceeded rural gains in each case, thus bringing about a rapid urban development in every type-of-farming area. In the case of the total population, the Rice area showed the greatest gain in urban population. At the other extreme, the Cane area showed the smallest percentage increase in urban population. But even here it is very significant that an increase of only 20.7 per cent in the total population was accompanied by an increase of approximately 280 per cent in the urban population. And although the total population of the area decreased after 1910, the urban population continued to gain. Another very significant indication of the urbanward trend is seen in the fact that although the negro population of the Cane area fell off by 14.1 per cent, the negro population of the urban portions of the area more than doubled, gaining 130 per cent. The trends in the Upland Cotton area also deserve comment for the percentage increase of the urban white population reached its maximum here, although the gain in the total white population of this area ranked next to lowest, exceeding only that of the Cane area.*

TABLE II

Percentage Increases of the Total, White, and Negro Populations in Each Type-of-Farming Area, 1890 to 1930

Type-of-Farming Area and Race	Percentage Gain in Population		
	Total	Urban	Rural
Upland Cotton	94.5	946.0	56.7
White	148.3	1,456.7	93.3
Negro	46.4	359.8	23.5
Delta Cotton	90.7	712.3	51.0
White	250.4	1,183.9	166.0
Negro	26.3	405.4	5.9
Rice	248.4	1,129.7	171.8
White	222.9	1,085.3	236.7
Negro	383.3	1,232.4	160.8
Cane	20.7	279.4	8.2
White	64.3	432.2	43.0
Negro	–14.1	130.0	–21.0
Small Fruits and Vegetables	131.3	833.1	94.3
White	204.9	995.4	156.0
Negro	45.8	566.2	23.6

Analysis of the population growth by decades throws additional light upon trends, especially the slow and the vacillating trends in rural districts. As noted above most of this was accounted for by the trends in the rural negro population. The tendency for rural negroes to become less numerous first manifested itself in the Delta Cotton area during the decade 1900 to 1910. A decrease in the total rural negro population of the Delta Cotton area also took place the next decade 1910 to 1920, but during this decade the same tendency also made its appearance in the Upland Cotton and the Cane areas. A decrease in the rural negro population in the cotton areas failed to occur from 1920 to 1930. However, during this decade, it was characteristic of the other three type-of-farming areas, the Cane, Rice and Small Fruits and Vegetables sections. The rural white population, on the other hand exhibited a much less fluctuating tendency. This element first showed a decrease in the decade 1910 to 1920, when losses occurred in the Upland Cotton and Cane areas. These losses were continued in the Cane area through the decade 1920 to

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* See the following section for further discussion of the relationship between type-of-farming area and the growth of population.

1930. During this decade a loss in the total rural white population also occurred in the Small Fruits and Vegetables area. These losses in the rural elements of the population tend to emphasize the relative gains by the urban elements.

INCREASE OF POPULATION AND TYPE OF FARMING

As indicated in the above pages marked differences in rate of population increases are shown by the different type-of-farming areas. Trends in their populations, subdivided according to race, are charted in Figure 19. During the forty-year interval 1890 to 1930, growth was most rapid in the Rice area, followed by the Small Fruits and Vegetables, Upland Cotton, Delta Cotton, and Cane areas in the order named. So rapid was the gain in the Rice area that the population more than tripled. The number of people increased from 43,057 to 149,999, which represents a gain of 248.4 per cent. Of the State's population living outside New Orleans, the proportion residing in the Rice area was only 4.9 per cent in 1890. By 1930 the corresponding percentage was up to 9.1. The per cent of the State's non-New Orleanian population which was resident in each of the type-of-farming areas at each decade 1890 to 1930, is charted in Figure 20.

The Small Fruits and Vegetables area was another region which was characterized by a very rapid growth of population. The number of people residing in this section more than doubled between 1890 and 1930. The actual increase in number of inhabitants was from 66,409 to 153,625, making a percentage increase of 131.3. This rapid gain advanced the area's proportion of the State's non-New Orleanian population from 7.6 per cent in 1890 to 9.4 per cent in 1930.

In the two Cotton areas, where the bulk of the State's population resides, substantial gains were also made. In the Upland Cotton districts the number of people increased from 323,245 to 628,649, a gain of 94.5 per cent. In the Delta sections the number of inhabitants increased from 246,819 to 470,769, or a gain of 90.7 per cent. Of the population of the State living outside the city of New Orleans, the proportions did not change much in these areas, being 36.9 and 38.3 in the Upland Cotton, 28.1 and 28.6 in the Delta Cotton areas for the years 1890 and 1930, respectively.

In sharp contrast to the magnitude of population growth in these four areas, the increase of population in the Cane area lagged far behind. The number of inhabitants was 197,018 in 1890 and 239,789 in 1930, or a gain of only 20.7 per cent. Such a slight absolute increase made for a considerable loss in relative importance. Thus in 1890 this area contained 22.5 per cent of the State's non-New Orleanian population, but by 1930 this percentage had dwindled to 14.6.

Very little similarity exists between the trends of population growth 1890 to 1930 in the various type-of-farming areas. The Rice area was characterized by remarkable increases of population during the first two decades (57.4 and 57.5 per cent gains) and a rapid falling off in the rate of increase to 23.2 (1910-1920) and to 14.1 for the decade 1920 to 1930.

The population in the area where small fruits and vegetables are the chief crops, grew more slowly during the early years, increasing 22.8 per cent during the first decade, and 30 per cent during the second; between 1910 and 1920 practically no increase took place, the gain being only 2.9 per cent; but the closing decade of the period saw an expansion of 40.9 per cent. Except in the Rice area during the first two decades of the period, this was the most rapid gain in any of the areas during any decade.

Trends in the two Cotton areas were rather similar, gains of 22.8 and 18.1 per cent for the Upland, 20.5 and 17.1 per cent for the Delta, respectively, taking place during the first and closing decades of the period. Each had one decade of slower growth; population in the Upland area expanding 23.7 per cent from 1900 to 1910, and only 8.5 per cent during the following decade; and population in the Delta districts growing only 10.9 per cent from 1910 and 1920, but increasing by 18.4 during the following decade.

In the Cane area, changes differed very materially from those in other sections of the State. Population in this region showed an increase of 27.4 per cent during the decade 1890 to 1900; this percentage of increase fell to 13.2 per cent for the decade 1900 to 1910; then between 1910 and 1920 a rapid decrease in population set in, amounting to 12.7 per cent during the decade, and being followed the next ten years by another decrease of 3.3 per cent. By 1930 the population of the Cane area was considerably under what it was in 1900, and only approximately equal to what it was in 1890.

The two major races showed very considerable differences in the rapidity with which they increased in the several type-of-farming areas. See Figure 19. The negro rate exceeded the white only in the Rice area, where their percentage increase was 383.3 between 1890 and 1930 as compared with 222.9 among whites. But analysis by decades shows that they increased much faster than whites during the first three decades (88.3, 80.7, and 34.9 as compared with 51.4, 51.8 and 20.2 per cent) and much slower during the last decade of the period (only 5.3 compared with 16.9 per cent).

For the period 1890 to 1930, whites increased more rapidly than negroes in the other four type-of-farming areas. The comparative percentages of increase for whites and negroes, respectively, are: 148.3 and 46.4 in the Upland Cotton area; 250.4 and 26.3 in the Delta Cotton area; 64.3 and a loss of 14.1 in the Cane area; and 204.9 and 45.8 in the Small Fruits and Vegetables area. Analysis of the

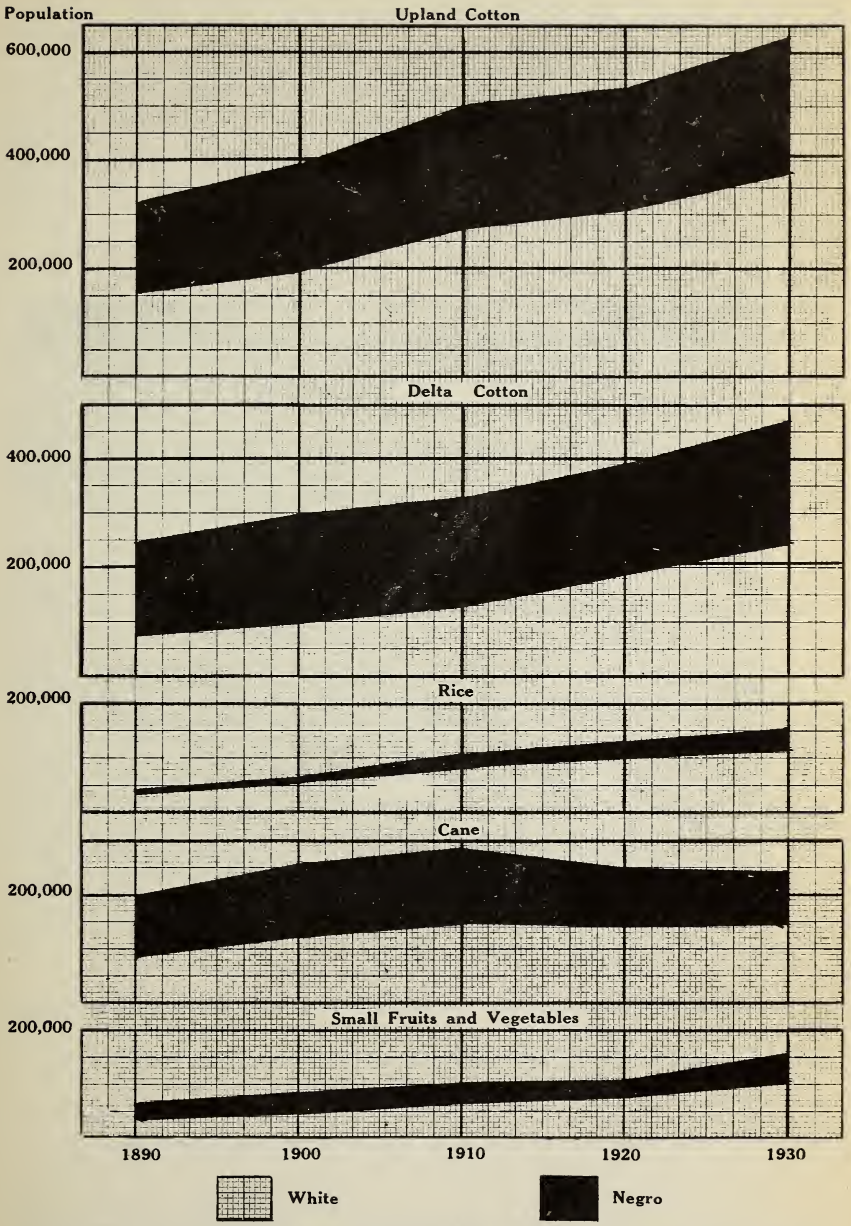

Figure 19.—Growth of the White and Negro Population in Each of the Type-of-Farming Areas, 1890 to 1930

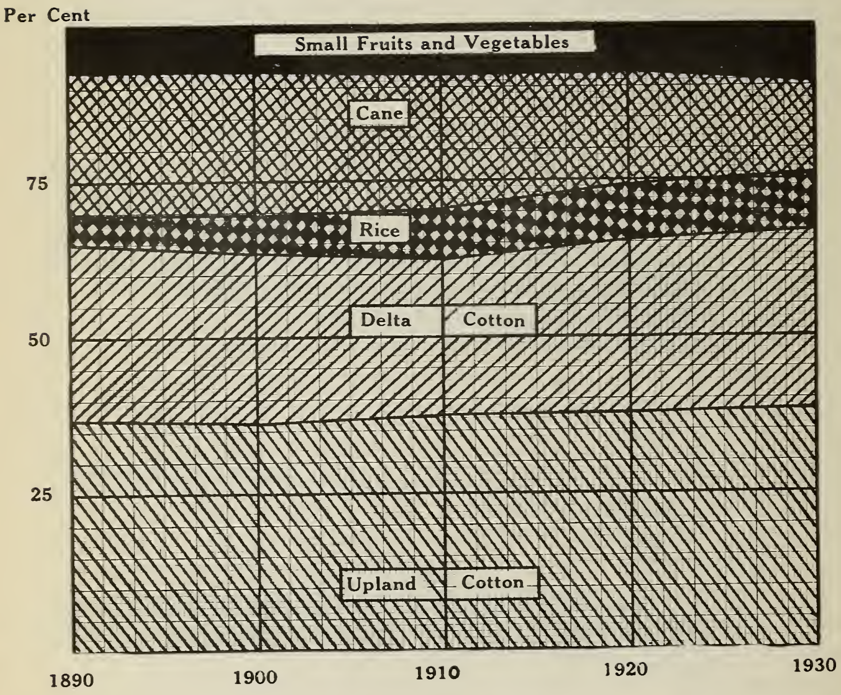

Figure 20.—Percentage Distribution of the Non-New Orleanian Population between the Type-of-Farming Areas, 1890 to 1930.

data by decades also shows whites consistently increasing more rapidly than negroes. In several instances a decrease occurred during a decade, negroes becoming less numerous between 1910 and 1920 in the Upland Cotton, Cane and Small Fruits and Vegetables area, and between 1920 and 1930 in the Cane area. Their number was also practically stationary between 1900 and 1920 in the Delta Cotton area. Whites lost in number only in the Cane area between 1910 and 1920.

Separate analysis of the data for the urban and rural portions of each area, shows that the greater speed of increase among negroes is confined to the urban portions; with the single exception of the urban portions of the Rice section, whites increased more rapidly than negroes in both the urban and rural portions of all the areas. Furthermore, rural negroes were less numerous in 1930 than they were in 1910, (except in the Rice and Small Fruits and Vegetables areas, which taken together contain less than 80,000 negroes).

SUMMARY AND CONCLUSIONS

This analysis of the growth of population in the State of Louisiana has revealed several significant findings:

1. Although the State has received practically none of the tremendous influx of foreign-born,* and despite the fact that she has made a net contribution of 116,939 persons to other states of the Union, population increase in Louisiana has been fast enough to keep pace with the very rapid increase in the United States as a whole. Between 1890 and 1930 population in the United States increased by 95.0, in Louisiana by 87.9 per cent.

2. The different sections of the State show enormous contrasts in the rate at which population has grown. The greatest gains were made in:

(a) Urban districts and the rural territory contiguous to them.

(b) The lumbering sections of southwestern Louisiana and the Florida parishes, both regions now largely "cutover."

(c) The rice growing area of southwestern Louisiana.

(d) The Small Fruit and Trucking region of southeastern Louisiana.

(e) Three parishes in northeastern Louisiana, West Carroll, Richland and Franklin, where a phenomenal migration of small farmers has been received.

(f) Webster parish in northwestern Louisiana.

However, the same period, in which the population of the State almost doubled, was characterized by decided losses in certain areas within the Commonwealth. The parishes which form the core of the "Sugar Bowl," parishes famed for their large cotton plantations (the Felicianas, Concordia and Tensas) and the parish of Plaquemines on the Mississippi below New Orleans, all lost population between 1890 and 1930.

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*The census of 1930 reported 14,204,149 persons, or 11.6 per cent of the total population, in the United States as foreign born. In contrast there were in Louisiana only 37,076 persons of foreign birth, 1.8 per cent of the total population.

3. Population gains were associated with the production of lumber, gas and oil, rice and truck crops, including strawberries. Losses in population were associated with the production of sugar cane and cotton on large farming units.

4. The distribution of these gains and losses was such that larger and larger portions of Louisiana's farming population have come to be concentrated on the poorer soils of the State.

5. Growth among the white population was greatly in excess of that among the negro. Part of this is due to excessive migration of negroes from the State. And yet had Louisiana lost neither negroes or white people by emigration, the rate of increase among negroes would have amounted to less than half the rate among the white population, 58 as compared to 137 per cent. The relative loss in the negro population occurred in all parts of the State except the Rice area where negroes has previously been very lightly represented. It was especially marked in the Cane area, where the decrease was absolute as well as relative. But despite these statewide trends, the negro population of New Orleans and the other urban areas in the State increased more rapidly than the white.

6. The rapid increase in the number of urban residents was one of the most significant changes in the State's population. The striking development has been the appearance and growth of small cities and towns, population increase in the City of New Orleans, between 1890 and 1930, being approximately equal to that of the State as a whole. But outside New Orleans, the number of urban centers increased from nine to forty-seven, the number of places with populations between 10,000 and 100,000 from two to seven, and the number of parishes containing urban centers from ten to thirty-six. This brought about an increase of urban population from 283,845 in 1890 to 833,532 in 1930, or an increase in the percentage of population in urban centers from 25.4 to 39.7. However these data do not give a complete picture of the concentration of population in urban areas, since the growth of population in the rural districts surrounding the urban centers has far outstripped the increase in the more remote regions.

APPENDIX

TABLE I

TOTAL POPULATION AND PER CENT OF POPULATION THAT WAS WHITE IN LOUISIANA BY PARISHES, 1890 TO 1930

Parish	1890		1900		1910		1920		1930	
	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White
State	1,118,588	49.9	1,381,625	52.8	1,656,388	56.8	1,798,509	61.0	2,101,593	62.7
Allen	3,846*	78.8	5,816*	74.2	12,424*	66.8	18,382	64.8	15,261	72.3
Acadia	13,231	87.7	23,483	79.4	31,847	79.3	34,820	78.4	39,326	79.4
Ascension	19,545	42.1	24,142	49.9	23,887	52.9	22,155	57.2	18,438	61.5
Assumption	19,629	54.6	21,620	56.3	24,128	58.1	17,912	58.2	15,990	60.5
Avoyelles	25,112	51.4	29,701	59.8	34,102	64.5	35,300	70.6	34,926	71.6
Beauregard	4,584*	83.2	6,862*	79.0	14,303*	72.4	20,767	70.6	14,569	77.7
Bienville	14,108	55.6	17,588	53.1	21,776	56.5	20,977	58.9	23,789	55.8
Bossier	20,330	20.2	24,153	21.8	21,738	23.0	22,266	29.4	28,388	36.9
Caddo	31,555	25.4	44,499	31.1	58,200	37.8	83,265	54.6	124,670	54.1
Calcasieu	7,490*	85.1	11,376*	81.2	22,956*	75.3	32,807	73.4	41,963	71.1
Caldwell	5,814	46.5	6,917	55.5	8,593	59.7	9,514	68.6	10,340	71.8
Cameron	2,828	84.9	3,952	85.4	4,288	87.4	3,952	85.2	6,054	90.5
Catahoula	6,520*	44.3	8,887*	44.2	10,415	50.0	11,074	53.7	12,451	62.6
Claiborne	23,312	42.0	23,029	40.0	25,050	40.4	27,885	46.9	32,285	44.0
Concordia	14,871	11.8	14,559	12.6	14,278	16.4	12,466	21.2	12,778	28.1
DeSoto	19,860	33.4	25,063	32.6	27,689	35.2	29,376	39.0	31,016	37.9
East Baton Rouge	25,922	36.6	31,153	33.9	34,580	38.2	44,513	48.1	68,208	56.8
East Carroll	12,362	8.1	11,373	8.4	11,637	10.7	11,231	13.6	15,815	25.1
East Feliciana	17,903	29.0	20,443	27.2	20,055	27.5	17,487	31.3	17,449	31.9
Evangeline	11,199*	64.4	15,462*	69.3	20,006*	72.3	23,485	75.8	25,483	77.3
Franklin	6,900	41.4	8,890	43.5	11,989	56.1	24,100	55.5	30,530	62.9
Grant	8,270	58.6	12,902	71.6	15,958	69.5	14,403	71.9	15,709	68.5
Iberia	20,997	50.1	29,015	50.7	31,262	53.7	26,855	59.4	28,192	61.9
Iberville	21,848	30.6	27,006	36.5	30,954	38.1	26,806	42.6	24,638	48.3
Jackson	7,453	65.0	9,119	64.9	13,818	71.1	14,486	72.3	13,808	71.1

Jefferson	13,221	50.8	15,321	58.6	18,247	62.3	21,563	72.3	40,032	79.6
Jefferson Davis	4,256*	85.6	6,374*	81.9	13,084*	75.9	18,999	74.5	19,765	74.8
Lafayette	15,966	56.9	22,825	58.3	28,733	62.6	30,841	64.9	83,827	65.8
Lafourche	22,095	64.6	28,882	71.4	33,111	75.9	30,344	80.6	32,419	83.6
LaSalle	5,482*	75.1	7,464*	74.9	9,402	79.0	9,856	84.3	11,668	81.7
Lincoln	14,753	57.5	15,898	57.5	18,485	60.5	16,962	62.8	22,822	57.5
Livingston	5,769	84.9	8,100	85.9	10,627	87.0	11,643	85.7	18,206	77.2
Madison	14,135	6.6	12,322	7.3	10,676	11.4	10,829	16.3	14,829	35.0
Morehouse	16,786	21.0	16,634	23.5	18,786	25.6	19,311	32.0	23,689	42.5
Natchitoches	25,836	39.6	33,216	41.1	36,455	44.2	38,602	46.4	38,477	47.4
Orleans	242,039	73.3	287,104	72.8	339,075	73.6	387,219	73.8	458,762	71.4
Ouachita	17,985	31.4	20,947	37.5	25,830	45.2	30,319	54.1	54,337	64.8
Plaquemines	12,541	42.1	13,039	44.2	12,524	45.3	10,194	47.0	9,608	52.5
Pointe Coupee	19,613	23.9	25,777	25.6	25,289	32.2	24,697	39.3	21,007	41.9
Rapides	27,642	42.8	39,578	46.3	44,545	51.6	59,444	57.9	65,455	61.1
Red River	11,318	31.4	11,548	35.3	11,402	45.5	15,301	50.4	16,078	52.5
Richland	10,230	29.5	11,116	29.0	15,769	33.6	20,860	42.5	26,374	49.8
Sabine	9,390	77.9	15,421	80.5	19,874	79.0	20,713	78.9	24,110	70.4
St. Bernard	4,326	54.3	5,031	56.3	5,277	63.4	4,968	67.8	6,512	79.1
St. Charles	7,737	25.7	9,072	32.7	11,207	40.0	8,586	49.4	12,111	65.2
St. Helena	8,062	43.1	8,479	45.9	9,172	50.1	8,427	49.8	8,492	45.7
St. James	15,715	36.2	20,197	43.8	23,009	42.8	21,228	45.3	15,338	50.5
St. John	11,359	41.2	12,330	41.7	14,338	43.3	11,896	46.0	14,078	50.7
St. Landry	29,051*	36.7	37,444*	41.3	46,655*	44.8	51,697	48.6	60,074	50.9
St. Martin	14,884	47.4	18,940	53.1	23,070	57.4	21,990	64.1	21,767	65.3
St. Mary	22,416	35.6	34,145	40.4	39,368	45.8	30,754	48.7	29,397	51.1
St. Tammany	10,160	63.0	13,335	63.1	18,917	64.4	20,645	62.9	20,929	66.2
Tangipahoa	12,655	62.8	17,625	69.5	29,160	68.7	31,440	71.7	46,227	66.1
Tensas	16,647	6.9	19,070	6.5	17,060	8.5	12,085	14.6	15,096	28.4
Terrebonne	20,167	51.6	24,464	57.8	28,320	60.0	26,974	65.2	29,816	68.7
Union	17,304	57.2	18,520	62.4	20,451	63.6	19,621	68.8	20,731	68.0
Vermilion	14,234	79.6	20,705	81.9	26,390	82.9	26,482	82.7	33,684	86.9
Vernon	5,903	90.9	10,327	87.6	17,384	78.6	20,493	75.1	20,047	81.7
Washington	6,700	69.2	9,628	71.1	18,886	71.1	24,164	69.4	29,904	67.5
Webster	12,466	41.5	15,125	45.4	19,186	48.4	24,707	53.9	29,458	55.6
West Baton Rouge	8,363	28.7	10,285	22.9	12,636	27.0	11,092	32.5	9,716	36.9
West Carroll	3,748	38.4	3,695	42.2	6,249	56.4	8,857	73.2	13,895	79.6
West Feliciana	15,062	15.1	15,994	13.8	13,449	18.1	12,303	17.2	10,924	23.5
Winn	7,082	85.7	9,648	82.6	18,357	78.6	16,119	79.0	14,766	75.0

* Estimated.

TABLE II

NUMBER AND PER CENT OF POPULATION RESIDING IN UNINCORPORATED TERRITORY OF EACH PARISH, 1890 TO 1930

Parish	1890		1900		1910		1920		1930	
	Number	Per Cent of Total Population	Number	Per Cent of Total Population	Number	Per Cent of Total Population	Number	Per Cent of Total Population	Number	Per Cent of Total Population
The State	786,118	70.3	949,364	68.7	1,050,070	63.4	1,041,291	57.9	1,134,007	54.0
Acadia	12,242	92.5	17,984	76.6	22,147	69.5	23,216	66.7	24,581	62.5
Allen	3,846	100.0	5,603	96.3	11,557	93.0	12,352	67.2	10,182	66.7
Ascension	16,424	84.0	20,037	83.0	19,797	82.9	18,410	83.1	14,188	76.9
Assumption	18,906	96.3	20,675	95.6	22,927	95.0	16,741	93.5	14,810	92.6
Avoyelles	24,129	96.1	26,756	90.1	28,293	83.0	29,359	83.2	26,951	77.2
Beauregard	4,584	100.0	6,862	100.0	12,203	85.3	14,269	68.7	8,196	56.3
Bienville	13,246	93.9	15,843	90.1	18,680	85.8	17,493	83.4	19,113	80.3
Bossier	20,025	98.5	23,238	96.2	19,922	91.6	20,517	92.1	22,571	79.5
Caddo	19,576	62.0	28,486	64.0	29,359	50.4	33,943	40.8	45,567	36.6
Calcasieu	4,048	54.0	4,696	41.3	10,792	47.0	14,741	44.9	18,706	44.6
Caldwell	5,462	93.9	6,535	94.5	8,093	94.2	8,743	91.9	9,235	88.5
Cameron	2,828	100.0	3,952	100.0	4,288	100.0	3,952	100.0	6,054	100.0
Catahoula	6,161	94.5	8,584	96.6	9,767	93.8	9,646	87.1	10,891	87.5
Claiborne	22,180	95.1	21,756	94.5	21,918	87.5	23,121	82.9	26,280	81.4
Concordia	14,050	94.5	12,537	92.5	12,356	86.5	10,176	81.6	9,135	71.5
DeSoto	18,320	92.2	23,143	92.3	24,985	90.2	25,215	85.9	24,976	80.5
East Baton Rouge	15,444	59.6	19,419	62.3	19,264	55.7	22,207	49.9	36,853	54.0
East Carroll	11,720	94.8	10,117	89.0	10,069	86.5	9,314	82.9	12,948	81.9
East Feliciana	15,372	85.9	16,742	81.9	15,942	79.5	13,781	78.8	12,100	69.3
Evangeline	11,199	100.0	15,299	98.9	19,403	97.0	20,920	89.1	22,558	88.5
Franklin	6,900	100.0	8,890	100.0	11,168	93.2	21,828	90.6	26,961	88.3
Grant	7,965	96.3	11,917	92.4	13,878	87.0	12,227	85.0	13,782	87.7
Iberia	16,241	77.3	20,295	69.9	21,174	67.7	17,508	65.2	17,248	61.2
Iberville	18,023	82.5	21,566	79.9	23,263	75.2	20,209	75.4	17,194	69.8
Jackson	7,453	100.0	9,119	100.0	11,390	82.4	12,102	83.5	9,601	69.5

Jefferson	12,268	92.8	14,068	91.8	18,247	100.0	12,484	57.9	23,129	57.8
Jefferson Davis	3,644	85.6	4,515	70.8	6,816	52.1	10,842	57.1	11,871	60.1
Lafayette	13,571	85.0	18,576	81.4	20,546	71.5	20,877	67.7	21,426	55.2
Lafourche	20,017	90.6	25,228	87.3	28,618	86.4	26,015	85.7	27,111	83.6
LaSalle	5,482	100.0	7,464	100.0	8,453	89.9	9,070	92.0	9,214	79.0
Lincoln	13,986	94.8	14,574	91.7	14,112	76.3	12,164	71.7	17,420	76.3
Livingston	5,769	100.0	8,100	100.0	9,461	89.0	10,772	92.5	16,680	91.6
Madison	14,135	100.0	12,322	100.0	9,829	92.1	9,513	87.8	11,497	77.5
Morehouse	16,490	98.2	15,034	90.4	16,458	87.6	15,914	82.4	16,659	70.3
Natchitoches	22,576	87.0	29,890	90.0	32,274	88.5	34,049	88.2	32,353	84.1
Orleans	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ouachita	14,282	79.4	14,744	70.4	14,494	56.1	15,404	50.8	21,743	40.0
Plaquemines	12,541	100.0	13,039	100.0	12,524	100.0	10,194	100.0	9,608	100.0
Pointe Coupee	19,613	100.0	25,007	97.0	23,641	93.5	23,071	93.4	18,926	90.1
Rapides	23,940	86.6	32,481	82.1	28,828	64.7	32,492	54.7	33,004	50.4
Red River	10,699	94.5	10,948	94.8	10,838	95.1	14,339	93.7	15,119	94.0
Richland	10,230	100.0	10,609	95.4	13,535	85.8	17,919	85.9	22,541	85.5
Sabine	9,257	98.6	14,491	94.0	17,323	87.2	18,271	88.2	20,241	84.0
St. Bernard	4,326	100.0	5,031	100.0	5,277	100.0	4,968	100.0	6,512	100.0
St. Charles	7,737	100.0	9,072	100.0	11,207	100.0	8,586	100.0	12,111	100.0
St. Helena	7,782	96.5	8,164	96.3	8,904	97.1	8,141	96.6	8,230	96.9
St. James	15,715	100.0	20,197	100.0	23,009	100.0	19,528	92.0	13,857	90.3
St. John	11,359	100.0	12,330	100.0	14,338	100.0	11,896	100.0	14,078	100.0
St. Landry	25,721	88.5	31,615	84.4	36,679	78.6	39,141	75.7	44,177	73.5
St. Martin	12,416	83.4	16,360	86.4	18,947	82.1	17,514	79.6	17,438	80.1
St. Mary	17,229	76.9	28,408	83.2	24,853	63.1	16,628	54.1	15,434	52.5
St. Tammany	7,234	71.2	9,193	68.9	10,867	57.4	11,621	56.3	12,048	57.6
Tangipahoa	9,994	79.0	12,246	69.5	17,893	61.4	19,830	63.1	29,852	64.6
Tensas	16,174	97.2	18,055	94.7	15,451	90.6	10,470	86.6	13,185	87.3
Terrebonne	18,887	93.7	21,252	86.9	23,296	82.3	21,814	80.9	23,285	78.1
Union	16,832	97.3	17,789	96.1	18,550	90.7	17,697	90.2	17,891	86.3
Vermilion	13,597	95.5	18,578	89.7	21,296	80.7	19,874	75.0	24,769	73.5
Vernon	5,903	100.0	9,179	88.9	13,319	76.6	15,213	74.2	15,903	79.3
Washington	6,603	98.6	9,392	97.5	17,142	90.8	14,450	59.8	14,501	48.5
Webster	11,168	89.6	13,564	89.7	16,184	84.4	16,954	68.6	20,734	70.4
West Baton Rouge	8,363	100.0	10,285	100.0	12,246	96.9	9,299	83.8	7,422	76.4
West Carroll	3,748	100.0	3,685	100.0	5.851	93.6	8,157	92.1	12,654	91.1
West Feliciana	13,504	89.7	14,180	88.7	11,853	88.1	11,396	92.6	10,094	92.4
Winn	7,082	100.0	9,648	100.0	14,276	77.8	12,734	79.0	10,609	71.8

TABLE III

POPULATION, URBAN AND RURAL POPULATIONS AND PER CENT OF WHITES IN URBAN AND RURAL POPULATIONS IN EACH TYPE-OF-FARMING AREA, 1890 TO 1930

	1890	1900	1910	1920	1930
State:					
Total Population	1,118,588	1,381,625	1,656,388	1,798,509	2,101,593
Urban Population	283,845	366,288	496,516	628,163	833,532
Per Cent Whites in Urban Population	69.2	67.9	67.5	69.6	68.9
Rural Population	834,743	1,015,337	1,159,872	1,170,346	1,268,061
Per Cent Whites in Rural Population	43.3	47.4	52.2	56.3	58.7
Upland Cotton:					
Total Population	323,245	396,844	490,766	532,378	628,649
Urban Population	13,734	22,962	45,425	85,620	143,655
Per Cent Whites in Urban Population	44.2	45.6	51.5	63.6	65.8
Rural Population	309,511	373,882	453,994	446,758	484,994
Per Cent Whites in Rural Population	46,6	50.0	55.0	56.8	57.5
Delta Cotton:					
Total Population	246,819	297,374	329,804	390,377	470,769
Urban Population	14,840	21,661	41,760	64,772	120,543
Per Cent Whites in Urban Population	39.3	46.0	49.7	58.5	62.1
Rural Population	231,979	275,713	288,044	325,605	350,226
Per Cent Whites in Rural Population	27.8	31.5	37.4	46.4	49.0
Rice:					
Total Population	43,057	67,754	106,701	131,490	149,999
Urban Population	3,442	10,894	23,380	33,217	42,326
Per Cent Whites in Urban Population	70.2	61.7	62.3	65.8	67.6
Rural Population	39,615	56,860	83,321	98,273	107,673
Per Cent Whites in Rural Population	84.7	84.0	81.7	78.8	81.3
Cane:					
Total Population	197,018	251,026	284,083	248,006	239,789
Urban Population	9,790	23,667	37,724	37,324	37,144
Per Cent Whites in Urban Population	49.5	53.7	55.1	62.5	69.4
Rural Population	187,228	227,359	246,359	210,682	202,645
Per Cent Whites in Rural Population	44.8	48.8	51.7	55.7	59.2
Small Fruits and Vegetables:					
Total Population	66,409	81,523	105,959	109,039	153,625
Urban Population	3,332	4,620	15,060	20,011	31,092
Per Cent Whites in Urban Population	62.2	67.5	69.3	69.0	73.0
Rural Population	63,077	76,903	90,899	89,028	122,538
Per Cent Whites in Rural Population	53.1	58.6	61.5	67.0	70.0

TABLE IV

POPULATION OF THE STATE, URBAN AND RURAL, AND PERCENTAGE OF POPULATION THAT WAS WHITE

	1890		1900		1910		1920		1930	
	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White	Population	Per Cent White
Total	1,118,588	49.9	1,381,625	52.8	1,656,388	56.8	1,798,509	61.0	2,101,593	62.7
Urban	283,845	69.2	366,288	67.9	496,516	67.5	628,163	69.6	833,532	68.9
Rural	834,743	43.3	1,015,337	47.4	1,159,872	52.2	1,170,346	56.3	1,268,061	58.7
Per Cent Urban		25.4		26.5		30.0		34.9		39.7
Per Cent Rural		74.6		73.5		70.0		65.1		60.3
Large Cities	242,039	73.3	287,104	72.8	339,075	73.6	387,219	73.8	458,762	71.4
Small Cities	22,457	39.6	27,282	44.4	75,783	50.6	108,929	59.7	200,892	63.4
Large Towns	000	00.0	24,571	52.8	29,491	58.0	52,377	66.1	72,564	70.0
Small Towns	22,681	54.4	27,331	54.1	52,167	58.2	80,638	64.2	101,279	67.5
Large Villages	23,689		35,595		57,116		68,213		78,415	
Small Villages	24,935		30,378		52,686		60,842		55,639	
Unincorporated Territory	786,119		949,364		1,050,070		1,041,291		1,134,007	

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EFFECT OF SOYBEANS ON CORN YIELDS

By
H. B. BROWN

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EFFECT OF SOYBEANS ON CORN YIELDS

By H. B. BROWN*

INTRODUCTION

During recent years there has been a decided increase in the number of acres of soybeans grown in the United States. In the Northern States, the plant is grown for hay, soil improvement, and for the grain or seed from which oil is extracted and food made. In the Southern States the plant is used principally for hay and for improving the soil.

With the increase in the use of the soybean have arisen many questions in regard to its use in cropping systems and in corn culture. A number of experiment stations have carried on cultural experiments, but results have differed considerably, due, no doubt, to the different soil and environmental conditions prevailing at various places. The kinds of soybeans grown and conditions vary so much that it is necessary to conduct many experiments. The object of the research outlined in this bulletin was to get information on the effect of soybeans on corn production in central and southern Louisiana when the two are planted in the same row at the same time; when planted in alternate rows and in the same row; when various rates of bean seeding are used; and on the value of the soybean as a soil renovater when plowed under or taken off for hay.

Materials and Methods

The soil in southern Louisiana is generally fertile and there is usually abundant rainfall. Plants tend to make luxuriant vegetative growth. The particular land used in the experiments mentioned below was land that had been farmed for many years but was in fair condition in respect to fertility. Experiments 1, 2, and 4 mentioned below were conducted on a bench land, classed as Denham silt loam. It was formerly classed as Memphis silt loam. Experiment 3 was conducted on Mississippi River alluvial land. All the plats were fertilized each year before planting with 300 pounds of 16 per cent superphosphate, 50 pounds nitrate of soda, and 50 pounds of muriate of potash per acre.

Cocke's Prolific, a vigorous-growing, medium-late, prolific variety of corn was used in experiments 1, 2, and 4, while Yellow Creole, a similar variety in period of maturity and vegetative growth, was used in the third. Otootan soybeans, or another variety of the same spreading and viney type, were used.

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*At present the soybean work of the Louisiana Agricultural Experiment Station is in charge of John P. Gray. The projects discussed in this bulletin were started by the writer before Mr. Gray took charge of the soybean work and were continued until completed. However, thanks are due Mr. Gray, John Cotton, and other of my associates in the Crops and Soils Department for assistance in various ways.

Except in the rate of seeding test, the planting was done with a one-horse planter on which there was a duplex hopper with six cups on a side. This planted hills of corn and beans in alternation, the hills being 27 inches apart. The rows were four feet apart. There were from three to five kernels of corn and six or eight beans dropped in a hill. The seeds of both were scattered somewhat as they fell. In 1933, the corn plants were thinned to two in a hill. Other years they were thinned to one stalk. The beans were not thinned. Good stands were secured, as a rule, but they were damaged somewhat by birds and insects. Some replanting was done nearly every year.

Five-row plats containing approximately one-twentieth acre each were used with four or five replications. Only the three middle rows of the plats were harvested for experimental weights. The corn was planted about March 20 each year. This is considered a good date for planting corn in the locality.

Effect of soybeans on corn yields when planted in the corn row at the time the corn was planted.

As a rule, soybeans growing in a row of corn tend to interfere with the growth of the corn somewhat like weeds do when growing in the row. The heavier the growth of the bean vines, the poorer the soil, and the scarcer the supply of moisture in the soil, the more harm the beans do. In general, it appears that they do more harm to the corn in the Northern States than in the South.

Hackleman (1) and others at the Illinois Experiment Station in a four-year test found that in checked corn, soybeans planted in the hills of corn reduced yields of corn 10.17 per cent, but that the combined feeding value of the corn and soybeans was considerably more than that of the corn alone. The digestible protein per acre on the "corn alone" plats was 136.3 pounds, while the protein from corn and Ebony soybeans was 212.5 pounds; corn and Hong Kong soybeans, 204.6 pounds; and corn and Ito San soybeans, 165.2 pounds. The Ito San soybeans, an early dwarf type, damaged the corn less than the others, but made the least protein.

Thatcher (2) of the Ohio Experiment Station reports that, in a five-year test of corn and soybeans, at a medium rate of planting (corn plants 12-14 inches apart and soybeans 4-5 inches) the corn and soybeans together yielded 34.9 pounds more grain per acre than the corn alone. Sixteen and four-tenths (16.4) per cent of the grain mixture was soybeans.

At the Kentucky Station (3), in a six-year test, there was an average loss of 5.7 bushels of shelled corn per acre when soybeans were planted in the corn, while the beans yielded 3.5 bushels of grain per acre.

The Missouri Experiment Station (4) reports that a five-year average yield of corn on average upland soil was 42 bushels per acre.

In a corn and soybean combination on the same land during the same period the yield of corn was 35 bushels per acre and the soybeans 3.5 bushels.

Mooers (5) of the Tennessee Experiment Station reports that the average yield of six crops of corn grown with soybeans on land of good productivity was 32.3 bushels per acre; whereas, under otherwise like conditions, corn alone produced 49.9 bushels, or 17.6 bushels more per acre. The grain yields of the beans in the corn was 17.1 bushels per acre. This just about balanced the corn loss. If the feeding value of the combination crop or its effect on the soil is considered, it is evidently the more desirable crop of the two.

Ayres (6) of the Mississippi Delta Experiment Station at Stoneville, Mississippi, reports averages of a four-year test of corn and soybeans on alluvial land as follows: corn alone, 24.2 bushels per acre; corn and beans in same row and planted at the same time, 17.7 bushels of corn and 7.1 bushels of beans. The grain total of the combination crop was 28.8 bushels, which was slightly more than the corn alone. When the beans were planted in the row of corn three weeks after the corn was planted, the corn produced a yield of 22.5 bushels of grain.

Experiments similar to the ones mentioned above have been carried on by other Experiment Stations. Results have been similar. In practically every case, there was considerable decrease in the grain yield of corn when soybeans were planted with the corn, but this loss was about balanced by the weight of the bean grain. Very few of the experimenters state whether or not the corn and beans were grown on the same land successive years. Since they do not mention any improvement of the soil due to the continued use of the beans, it may be assumed that the corn and bean plats were moved from year to year.

Louisiana Experiments

In 1929, experimental work was started by the Louisiana Experiment Station to obtain some information on the questions mentioned on the first page of this bulletin. The experiments were carried on satisfactorily for a period of five years, but had to be discontinued then due to the use of the land for building sites.

1929 Experiments

Corn yields depend to a considerable extent on the amount of rainfall and on its distribution throughout the corn growing season. The dependence is even greater when soybeans are planted in the corn. The following weather tables show the Baton Rouge rainfall from March to August for the years that the experiments were run, and may be of some aid in interpreting results.

Rainfall at Baton Rouge, Louisiana, in 1929.

Month	Total for Month	Departure from Normal	Number of days with .01 or more inches of rain.
March	5.40	+0.55	8
April	1.76	—2.93	6
May	9.30	+4.50	12
June	5.90	+1.11	13
July	3.75	—3.02	13
August	6.21	—0.45	12

Plat Weights of Ear Corn in 1929

	Plats with corn and beans			Plats with corn alone		
Series I	22.6	18.5	16.4	29.1	23.8	26.1
Series II	16.5	14.4	13.1	23.4	24.9	21.5
Series III	24.7	20.7	19.2	24.9	28.8	35.6
Series IV	22.4	22.1	24.7	33.7	34.1	30.4
Series V	17.9	20.2	21.0	29.0	36.8	38.8
Total Weight 294.4 pounds				440.7		
Bushels per acre 28.0 ± .87				41.9 ± 1.34		

The plats with soybeans had an average of 31 stalks per row, while the ones without beans had 37.6 stalks. Figuring the yields on the basis of equivalent stands, the yields are 33.9 and 41.9 bushels per acre. This makes a difference of eight bushels per acre. Basing yields on stalk numbers in this way probably gives the plats with the lower number of stalks some advantage. However, the plats without beans had more stalks blown down or lying on the ground, and the ears were heavier because they contained more moisture. These two factors practically balance each other. Using the figures for equivalent stands, the plats with beans yielded 19.1 per cent less corn than the ones without beans.

The beans in the plats made vigorous growth and covered all the space between the rows. A yield of 4020 pounds of dry soybean hay was made. There was a fair crop of bean seed, but these were not harvested. All of the bean residue was left on the land each year.

The "corn alone" plats yielded several more bushels of grain than the plats with beans, but if we consider the value of the soybean hay produced and, in addition, the soil improvement from the use of the beans, it was evidently more profitable to have them.

Rainfall at Baton Rouge, Louisiana, in 1930

Month	Total for Month	Departure from Normal	Number of days with .01 or more inches of rain.
March	4.91	+0.06	14
April	2.01	—2.68	3
May	6.23	+1.43	7
June	T.	—4.79	0
July	4.92	—1.85	10
August	4.85	—0.91	9

The corn-growing period of 1930 was considerably below the normal in amount of rainfall.

Plat Weights of Ear Corn in 1930

	Plats with corn and beans			Plats with corn alone		
Series I	13.2*	13.2	13.3	22.2	20.4	19.7
Series II	8.2	9.1	10.5	15.3	16.3	14.4
Series III	12.0	11.6	11.7	18.0	18.8	18.3
Series IV	10.7	10.4	8.4	18.2	15.1	14.2
Series V	10.6	12.5	12.5	12.7	15.0	23.4
Total plat weight	167.9 pounds			262.0 pounds		
Bushels per acre	25.9 ± .67			40.7 ± 1.87		

*A part of each plat was blocked off and not harvested for yield.

The season of 1930 was drier than a normal season and the soybeans in the corn reduced yields more than usual. There was a loss of 33.6 per cent due to the effect of the beans. A yield of 2736 pounds of soybean hay was produced.

Rainfall at Baton Rouge, Louisiana, in 1931

Month	Total for Month	Departure from Normal	Number of days with .01 or more inches of rain.
March	4.32	—0.53	9
April	2.27	—2.42	8
May	5.31	+0.61	9
June	1.84	—2.95	6
July	6.42	—0.35	14
August	8.23	+2.47	16

The crop season of 1931 had less rainfall than a normal season.

Plat Weights of Ear Corn in 1931

	Plats with corn and beans			Plats with corn alone		
Series I	20.8	19.9	18.8	13.0	11.0	12.8
Series II	15.4	15.5	14.3	12.8	12.4	16.7
Series III	15.3	17.3	13.6	13.5	17.5	14.6
Series IV	12.0	11.1	15.3	11.2	17.8	13.1
Series V	13.8	15.4	13.7	13.5	9.3	16.3
Total plat weight	232.2 pounds			205.5 pounds		
Bushels per acre	22.1 ± .68			19.6 ± .68		

The season of 1931 was too dry for good corn yields. The soybean plats that year made slightly higher yields than the "corn alone" plats. The beans had some beneficial effect on the soil, probably because the plats that had grown beans made 12.7 per cent more corn than did the plats which had not had beans. The soybeans made good growth, but no hay weights were taken.

Rainfall at Baton Rouge, Louisiana, in 1932

Month	Total for Month	Departure from Normal	Number of days with .01 or more inches of rain.
March	3.21	—1.68	7
April	5.49	+1.11	7
May	8.39	+3.66	11
June	2.80	—1.97	7
July	7.53	+1.15	15
August	5.52	—0.12	15

The rainfall during the growing season of 1932, with the exception of May, which was rather wet, was nearly normal.

Plat Weights of Ear Corn in 1932

	Plats with corn and beans			Plats with corn alone		
Series I	23.0	24.5	23.5	21.0	18.5	17.0
Series II	21.5	27.0	26.5	21.0	19.0	18.0
Series III	24.0	24.5	25.5	16.0	18.0	15.5
Series IV	22.5	26.0	23.5	13.5	13.5	17.0
Series V	34.0	36.5	31.0	18.0	16.0	18.5
Total plat weight	393.5 pounds			260.5 pounds		
Bushels per acre	40.5 ± 1.21			26.7 ± .60		

Yields were fairly good in 1932. The bean plats outyielded the others by 51.7 per cent. The growth of the bean vines was good, 3478 pounds per acre of dry hay being produced.

Rainfall at Baton Rouge, Louisiana, in 1933

Month	Total for Month	Departure from Normal	Number of days with .01 or more inches of rain.
March	5.06	+0.17	9
April	7.92	+3.54	10
May	4.41	—0.32	5
June	3.83	—0.94	6
July	6.39	+0.01	20
August	5.72	+0.08	15

Except for April, the rainfall during the 1933 corn growing period was about normal.

Plat Weights of Ear Corn in 1933

	Plats with corn and beans			Plats without beans		
Series I	26.0	22.6	25.8	16.0	13.1	11.7
Series II	18.5	12.0	15.3	13.0	11.7	9.0
Series III	17.1	17.1	18.5	12.7	14.6	15.9
Series IV	15.3	16.6	14.3	10.6	13.9	15.8
Series V	17.5	16.6	15.7	13.0	14.1	13.4
Total plat weight	268.9 ± pounds			198.5 ± pounds		
Bushels per acre	33.0 ± 1.27			24.4 ± .63		

During the fore part of the growing season of 1933, the corn in the corn and bean plats made splendid growth and gave promise of making much better yields than the corn in the "corn alone" plats. However, during June the weather became rather dry for corn. The corn in the corn and bean plats was affected worse than in the other plats (see Figure 1.) and lost some of its margin, but it yielded more than the corn in the other plats by 35.2 per cent. As may be seen in Figure 1, the beans in the corn and bean plats

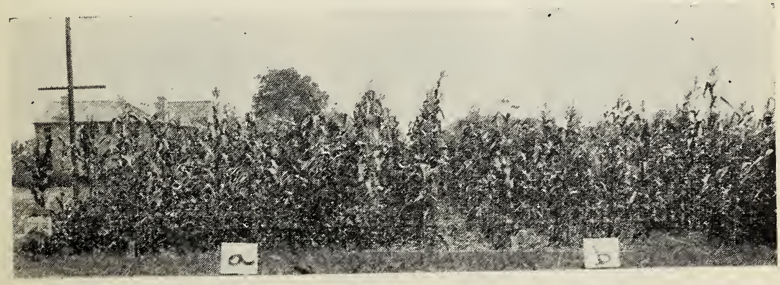

Figure 1

Corn plats with and without soybeans
a. Corn and soybeans.
b. Corn alone.

made good growth. Though the hay samples were taken before the beans had reached full growth, the hay yield was 2200 pounds per acre. The corn stover in the corn and bean plats weighed 5.8 tons per acre, while the stover from the "corn alone" plats weighed 4.4 tons. It was observed that the corn plants fired worse in the "corn alone" plats than in the other set, and that the soil renovating effect of the soybeans affected the two outer rows of the adjacent plats which had no beans. The effect was confined principally, though, to the outside row.

Figure 2 shows graphically the grain yields of both sets of plats for the entire period. There are some irregularities in the curves due to weather conditions of different years. However, it will be observed that the general trend of the curve for "corn alone" plats is downward, while that for the other plats is upward. The land at the beginning of the experiment was in fairly good condition and gave

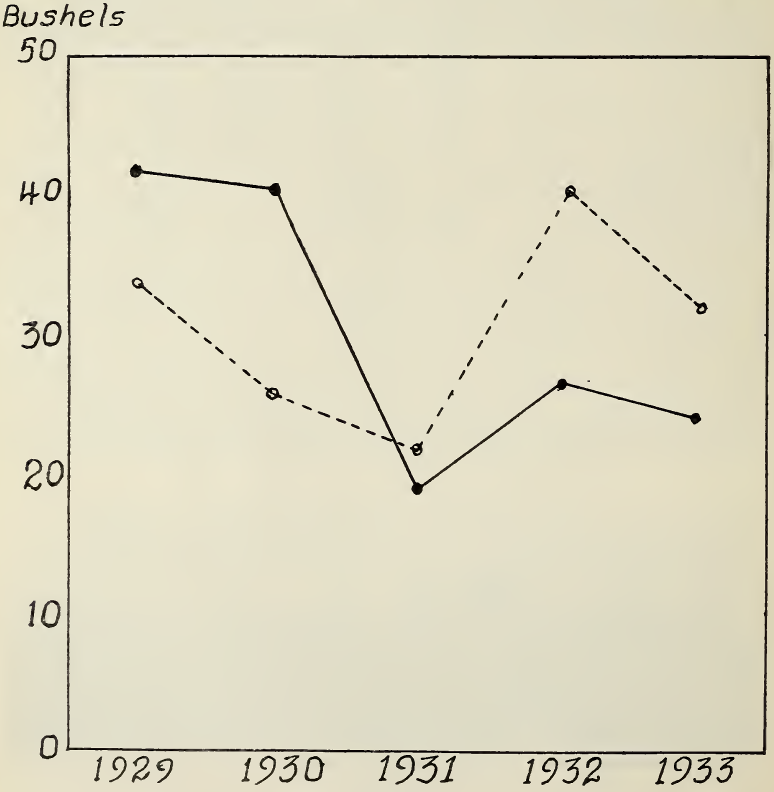

Figure 2

Bushels of corn per acre with and without soybeans planted in the row of corn when the corn was planted.

———— Without Soybeans - - - - - - - With Soybeans

Table I. Summary of data on the effect of soybeans on corn production when the beans were planted in the corn row when the corn was planted

Year	Bu. corn in "corn alone" plats	Bu. corn in corn and bean plats	Bean hay per acre on corn and bean plats	Av. No. Stalks per row		Corn stover on "corn alone" plats	Corn stover on corn and bean plats	% gain or loss from use of soybeans
				"Corn alone"	Corn and beans			
1929	41.9 ± 1.34	28.0 ± .87	4020 lbs.	37.6	31.0	----------	----------	—19.1
1930	40.7 ± 1.87	25.9 ± .67	2736 lbs.	38.0	36.3	----------	----------	—33.6
1931	19.6 ± .61	22.1 ± .68	lbs.	47.0	45.0	----------	----------	+12.7
1932	26.7 ± .60	40.5 ± 1.21	3478 lbs.	48.0	44.0	----------	----------	+51.7
1933	24.4 ± .63	33.0 ± 1.27	2200 lbs.	59.7	67.8	8800 lbs.	11,600 lbs.	+35.2

Table I brings together averages of data collected the different years the experiment was run. Most of this was mentioned in previous discussions. The yields of soybean hay shown in column 3 show considerable variation, although there was a good crop grown every year. The difference in weights is due largely to the time of cutting.

good yields on the "corn alone" plats. After the first two years, there was a decided falling off in production in the "corn alone" plats. The soybeans in the other series of plats lowered yields decidedly the first two years compared with the "corn alone" plats, but after that their beneficial effect on the soil began to show and yields were increased.

The number of stalks per row, shown in columns 4 and 5, varied some, although the same amount of seed was planted in each row each year. Four years out of the five the "corn alone" rows had the larger number. This probably gave the "corn alone" plats a slight advantage, although the advantage was somewhat less than the difference in the number of stalks would indicate. If the number of stalks is increased, the yield of each stalk is somewhat less.

Columns 6 and 7 show that considerably more corn stover was produced by the corn and bean plats in 1933 than was produced on the "corn alone" plats. Unfortunately, corn stover yields were not taken other years. It was very evident, though, judging from the looks of the corn, that there was more corn stover on the corn and bean plats during the later years of the experiment. During the first two years, the "corn alone" plats probably made more.

Every year the soybeans made good growth and covered practically all of the ground both in the rows and between. This served to prevent the growth of grass and weeds on the bean plats. There was considerable growth of grass and weeds on the other plats after the corn was laid by. All of the plats were plowed during the fall each year, and summer growth turned under. During the winter, there was a prolific growth of chickweed and other winter annuals on the plats that had grown beans, but slight growth on the others.

Table 2. Analysis of Soil in Corn and Soybean Test.*

Plats	Total organic matter (%)	Total phosphoric acid (%)	Total nitrogen (%)	Potash (acid soluble) (%)	Ph.
1. Corn and beans	2.060	.120	.103	.170	6.1
2. Corn alone	1.620	.105	.081	.150	6.1
3. Corn and beans	1.560	.0975	.078	.240	5.9
4. Corn alone	1.440	.090	.072	.250	5.8
5. Corn and beans	1.620	.0875	.081	.150	5.9
6. Corn alone	1.580	1.000	.079	.130	5.7
7. Corn and beans	1.680	.095	.084	.240	5.7
8. Corn alone	1.440	.080	.072	.180	5.7
9. Corn and beans	1.660	.080	.083	.210	5.8
10. Corn alone	1.620	.095	.081	.180	5.7
Av. corn and beans	1.716	.096	.085	.202	
Av. corn alone	1.540	.094	.077	.178	

* The soil analysis was made by A. P. Kerr and his associates.

A large number of Diabrotica beetles was observed to be wintering on this growth, during the winter of 1932-33. It was feared that these beetles would cause much budworm trouble in the corn on the bean plats the following spring, but a count of infested plants in the plats showed worse infestation in the corn where there had been no beans. We cannot give the reason for that. The covering of winter weeds probably lessened erosion to some extent. The corn stalks on the corn alone plats lodged or blew down worse than on the other plats.

During the winter of 1932-1933, ten samples were taken from the topsoil of each plat in the corn and soybean experiment and an analysis made. The results are shown in Table 2. When the samples were taken, the experiment had run four years on the same plats. The effect of the soybeans seems to be reflected rather clearly in the soil analysis. There is a considerable increase in organic matter in the soil, as was to be expected, and good increase in total nitrogen. There also appears to be a decided increase in the amount of potash. This, however, may be more apparent than real. The subsoil of this land contained considerably more potash than the top soil. If in sampling more of the subsoil were taken up, the sample would naturally test higher in potash.

Residual Effect of Soybeans in Corn on the Following Cotton Crop

It has been seen that growing soybeans in corn increased the yield of corn on the plats in subsequent years, and also improved the chemical composition of the soil. It has been observed by many cotton planters that the growing of a crop of corn and soybeans one year has a decidedly beneficial effect on the cotton crop that follows the next year. Ayres (6) of the Mississippi Delta Station secured an increase of 657 pounds of seed cotton per acre from soybeans planted in the corn row at the time the corn was planted, 717 pounds increase when planted in the row three weeks after the corn was planted, and 836 pounds increase when planted in rows alternating with the corn rows.

In the Louisiana experiments, cotton on the land that had been in corn and soybeans for five years made a much more vigorous growth than cotton that followed corn alone. Compare Figures 3 and 4. The average height of the cottons plants on the bean plats was 39.9 inches, while the average height of the cotton plants on the other plats was 27.5 inches. The cotton on the plats that had grown beans made approximately 100 per cent more cotton than the cotton on the other plats. The yield was reduced by boll weevils and in neither case was great, being about 937 pounds seed cotton per acre on the higher yielding plats.

Corn and Soybeans for Silage

Several experiment stations have carried on experiments to determine the value of planting soybeans in corn for silage. Results

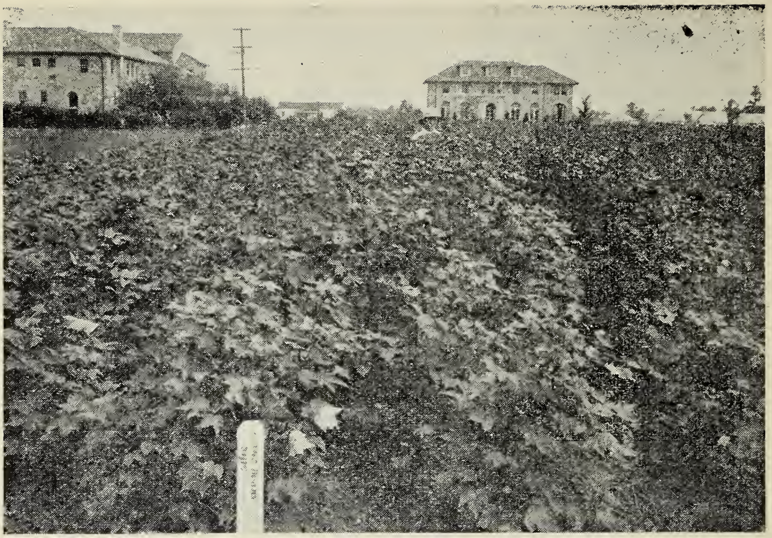

Figure 3

Cotton on land that had grown corn and soybeans for five years.

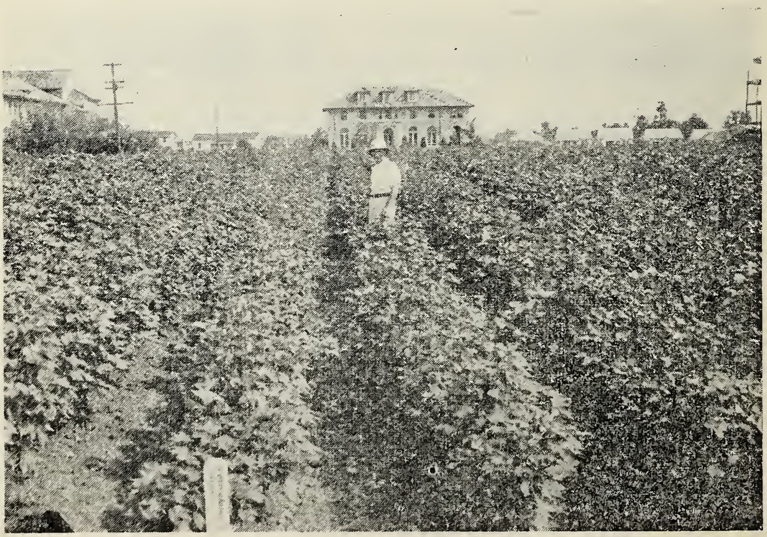

Figure 4

Cotton on land that had grown corn alone for five years.

have varied some. The Ohio Station (2) compared Clarage corn, a variety maturing a grain crop in a normal season, and Blue Ridge corn, a late silage variety, with and without soybeans for silage, during a seven-year period. Clarage corn alone averaged 8.28 tons of silage per acre, and Clarage corn and soybeans, 7.96 tons; Blue Ridge corn alone, 12.57 tons, and Blue Ridge and soybeans, 12.23 tons. The combination crop was slightly lower in yields, but probably of a higher feeding value, due to the higher protein content of the soybeans.

Odland (7), of the West Virginia Station, as a result of experiments carried on for five years, found that there was neither a significant increase or decrease in total yield of the combination crop as compared with corn alone if the corn was planted at the same rate as in the combination. He concluded that the advantage of the combination must come from its higher feeding value.

The Connecticut Experiment Station got an increased yield of about a ton of green matter from the combination crop. Iowa Station also secured increased yields. Others have obtained similar results.

Unfortunately, in our experiments the corn stover weights were taken only one year. This year, which was the last year the experiment was run, showed an increase of 4.7 tons of green matter per acre for the combination crop. If weights had been taken the first two years of the experiment, the gains would have been much less.

In none of the experiments from which we have seen data has the total value of the silage been reduced by growing beans in the corn. Other experiments have shown a decided increase. Since the use of the beans makes the silage considerably richer in protein, it seems that there is no question but that it is advisable to use them.

Economy of Growing Corn and Soybeans Together

When soybeans are planted in corn and they reduce the corn yield 20 per cent or more, it may seem that it is poor economy to use them. However, if we consider the value of the bean hay or the value of the bean seed produced in addition to the value of the corn, a different picture is presented even for the first year the beans are grown. On the Experiment Station farm for the five years ending 1933, Otootan soybeans, when grown alone, yielded on the average 6179 pounds of air-dry hay per acre. The first year the corn and bean experiment mentioned above was run, the "corn alone" plats made 41.9 bushels per acre. Two acres, then, when the crops were grown separately made 41.9 bushels of corn and 6179 pounds of hay, or an average per acre of 20.9 bushels of corn and 3089 pounds of hay. The corn and beans together the first year the experiment was run made 33.9 bushels of corn and 4020 pounds of hay. This was a considerably better acre production of both corn and hay than when the two were grown separately. Later years, after the beans had been grown on the land for a time, the margin in favor of the combination crop was even greater. Growing the beans on the land every year would evidently have a greater beneficial effect on the soil than when grown every other year in case a two-year rotation of corn and soybeans was used.

It may be suggested that if the corn and soybeans are grown together it is a difficult matter to save the soybean hay. It is true that it is more trouble to save the hay, but it is not such a hard task. After the corn grain has been gathered, the corn stalks and beans may all be mowed and put up for hay. The corn stalks add to the bulk considerably, but they furnish some additional feed. The corn may be cut and shocked and then the bean vines mowed, if pure soybean hay is preferred.

Mooers (5) of the Tennessee Station reports results similar to the ones given above, except that he gives yields of soybean seed instead of hay. He found that as an average of six crops when Tokio soybeans were grown alone, grown with corn, and corn grown alone, the corn alone produced an average of 49.9 bushels per acre; the beans alone, 25.9 bushels; the mixed crop yielded 32.3 bushels of corn and 17.1 bushels of beans per acre. The average acre yield for the two acres grown separately was 24.9 bushels of corn and 12.9 bushels of beans. For acre production, this shows a decided margin in favor of the mixed crop. Other investigators have secured results similar to the ones given in the two experiments mentioned above. Considering these figures, it seems that it is considerably more economical to grow the two crops together.

Effect of Soybeans on Corn Yields
When Planted in the Same and in Alternate Rows

In some localities, soybeans that are planted in corn are planted in rows alternating with the corn rows. When planted in this way, both the corn and beans are more easily harvested, but there may be some question as to whether or not this is the most profitable way to plant them. Akers and Westover (8) of the U. S. D. A. Forage Crop Field Station at West Point, Mississippi, tried planting corn alone, corn and Otootan soybeans in alternate rows, and Otootan soybeans alone. The corn alone made 23.5 bushels per acre; and the corn in rows alternating with bean rows, 14.3 bushels. The beans in the rows alternating with the corn made 1.1 tons hay per acre, while the beans alone made 2.2 tons of hay. The spacing of the corn plants in the two methods of planting mentioned is not given, but probably the stalks stood the same distance apart in the two sets of rows.

Etheridge and Helm (4) of the Missouri Experiment Station found that corn alone, planted three stalks to the hill in check row hills 44 inches apart each way, yielded 37.8 bushels of corn per acre; that corn alone, with the same spacing in the row as just mentioned

Table 3, below, gives the plat yields in pounds of ear corn for the five-year period and the acre yields in bushels. Since there was some difference in the number of stalks in plats that were compared, acre yields were computed on the basis of equivalent stands for some years.

Table 3. Corn and Soybeans in the Same and in Alternate Rows

Corn Grain Weights in 1929

	In Alternate Rows			Both in the Same Row					
Series 1.	44.9	45.5	47.1	25.7	23.5	26.2	24.5	29.0	33.0
Series 2.	37.1	44.4	45.4	26.0	25.4	24.2	27.2	22.8	22.4
Series 3.	49.8	39.6	39.0	28.9	27.7	35.2	34.4	32.3	28.4
Series 4.	51.5	48.0	49.5	29.8	29.5	33.6	31.5	33.2	27.7
Bushels per Acre, basis equivalent stands			36.6	------	------	------	40.7	------	------

Corn Grain Weights in 1930

	In Alternate Rows			Both in the Same Row					
Series 1.	20.6	22.0	28.3	6.8	10.6	14.2	9.4	7.1	8.5
Series 2.	27.0	24.3	24.3	9.4	7.5	9.6	10.8	10.9	10.7
Series 3.	18.1	20.2	26.5	9.0	9.3	6.1	7.2	10.2	9.0
Series 4.	23.1	20.6	25.3	9.4	11.5	9.4	9.6	10.8	12.3
Bushels per Acre, basis equivalent stands			18.1	------	------	------	15.8	------	------

Table 3. Corn and Soybeans in the Same and in Alternate Rows—Continued

Corn Grain Weights in 1931

	In Alternate Rows			Both in the Same Row					
Series 1.	25.0	25.1	28.1	15.7	15.3	11.5	13.5	15.9	10.1
Series 2.	20.8	22.4	29.2	12.8	11.6	13.3	13.1	15.1	13.0
Series 3.	20.7	25.7	32.0	16.4	11.8	12.0	14.5	14.1	13.7
Series 4.	20.9	21.6	24.5	15.0	12.5	13.3	13.7	16.0	14.7
Bushels per acre			19.0	------	------	------	------	21.1	------

Corn Grain Weights in 1932

	In Alternate Rows			Both in the Same Row					
Series 1.	26.3	28.0	30.2	17.5	15.5	19.5	16.4	17.5	18.6
Series 2.	31.6	33.1	30.1	15.4	14.6	16.4	17.3	13.8	15.1
Series 3.	23.3	24.7	26.1	19.3	20.2	18.2	19.0	18.5	19.8
Series 4.	21.4	25.3	23.3	16.2	14.4	18.0	15.3	16.1	17.2
Bushels per acre			32.3	------	------	------	------	40.9	------

Corn Grain Weights in 1933

	In Alternate Rows			Both in the Same Row					
Series 1.	33.4	34.7	------	21.0	16.0	16.9	14.5	------	------
Series 2.	22.9	20.8	------	15.7	12.8	13.0	14.0	------	------
Series 3.	22.9	20.2	------	13.5	14.1	12.0	13.7	------	------
Series 4.	25.3	16.5	------	13.0	16.1	13.0	13.2	------	------
Bushels per acre			22.6	------	------	------	------	26.3	------

Table 4. Summary of Data on the Effect of Planting Corn and Soybeans in the Same and in Alternate Rows

Year	Bu. corn alt. row plats	Bu. corn "every row" plats	Bean hay alternate row plats	Bean hay "every row" plats	Plants per row alt. row plats	Plants per row "every row" plats	Corn stover alt. row plats	Corn stover "every row" plats
1929	36.6	40.7	3777 lbs.	3982 lbs.	66.6	39.5	------	------
1930	18.1	15.8	2971 lbs.	3097 lbs.	79.3	37.8	------	------
1931	19.1	21.1	------	------	63.0	42.8	------	------
1932	32.3	40.9	3025 lbs.	2423 lbs.	55.0	28.6	------	------
1933	22.6	26.3	1833 lbs.	1956 lbs.	83.0	44.5	8433 lbs.	10037 lbs.
Average	25.7	28.9	2803 lbs.	2679 lbs.	69.4	38.6	------	------

but with rows alternating with rows of soybeans, yielded 25.4 bushels of corn. The beans in this test when grown alone yielded at the rate of 14.1 bushels per acre; when grown in rows alternating with corn rows, 8.5 bushels. The two crops when planted separately gave an average yield of grain per acre, beans and corn, of 25.9 bushels. When they were planted together in alternate rows, the average acre yield of grain was 33.9 bushels.

Louisiana Experiments

The Louisiana experiments with corn and soybeans in the same row and in alternate rows were carried on on plats adjacent to the plats on which the experiments with "Corn with and without soybeans" were conducted. Soil, fertilizer, and weather conditions were about the same, and the same varieties of corn and beans were used in the two experiments.

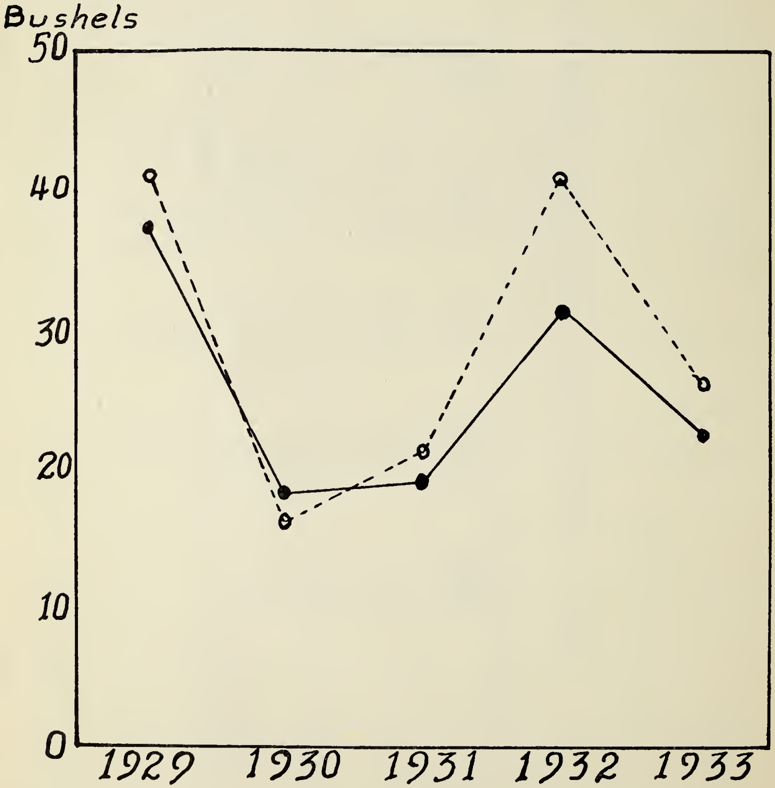

Figure 5

Relative yields of corn when planted in rows alternating with soybean rows and when both are planted in the same row.

———————In Alternate Rows - - - - - - - Both in same Row

In the alternate row experiment, two sets of plats of four each were used. There were three rows of beans and three rows of corn in each plat of one set, and six rows of corn with beans in all of the rows in the other set. The same amount of seed corn or of soybeans that was planted in three rows in one case was planted in six rows in the other, and when thinning the corn, an effort was made to preserve the same ratio. However, in four cases out of five there were some more plants in the six-row plats of corn. The beans were not thinned. The plats were rotated every year; that is, land used for the alternate row plats one year was used for the "every row" plats the next.

Figure 5 shows graphically the comparative yields, in bushels of corn, for the two sets of plats in the alternate row and "every row" experiment. The curves for both sets of plats are somewhat irregular, due to variation in weather conditions different years, but they vary together. The weather in June during both 1930 and 1931 was too dry to be favorable for corn production. In 1933, a hail-storm damaged the corn considerably. Tables 3 and 4 give details of yields. In all cases the plat that had the larger number of corn plants led in yield of grain. In 1929 and 1930, the acre yields were computed on the basis of uniform stands. The difference was barely significant. In 1932, a year when corn made good yields, there was a considerable margin in favor of the "every row" planting. On the other hand, in 1930, which was the driest year during the progress of the experiment, the alternate row planting made the most corn. Although the evidence is not very conclusive, it appears that under the less favorable conditions, the alternate row planting may be the most satisfactory. This accords with the views of farmers in poor land areas, and in regions where droughts are common.

The comparative difference in hay yields in Table 3 is not great enough to be significant. However, if the matter of harvesting the hay is considered, there is some advantage in favor of the alternate row planting.

Weights of corn stover produced were taken only in 1933. This year there was a considerable margin in favor of the "every row" planting. Judging from the appearance of the corn in the plats, the every row plats probably had the greater weight every year.

Since the "every row" system of planting made considerably more stover per acre, this is doubtless the best to use in growing corn for the silo. The soybeans made slightly greater tonnage in the alternate rows, but the difference was not great enough to balance the loss in corn stover.

If we compare the alternate row planting with the "corn alone" and "beans alone" plats nearby, we find that the yields are better in the combination crop. The average yield of soybeans alone for a five-year period was 6449 pounds of dry hay per acre; the average yield of "corn alone" for the five-year period was 30.6 bushels. This gives an average acre yield of 3224 pounds of hay and 15.3 bushels of corn. The combination crop during the same period of time gave an average of 25.7 bushels of corn and 2803 pounds of hay per acre.

Since the plats of the alternate and "every row" planting experiment were rotated each year, no difference in the residual effect was to be expected.

Effect of Rate of Soybean Seeding in Corn on the Production of Corn Grain, Corn Stover, and Soybean Vines

It is the general consensus of opinion that increasing the rate of seeding soybeans in corn will result in increased reduction of corn yields. Unfortunately, not much study has been made of this question. Etheridge and Helm (4) of the Missouri Experiment Station found that with corn in hills 44 inches apart each way, three stalks of corn and one bean plant per hill gave a yield of 52 bushels of corn and 0.9 bushels of soybeans; three stalks of corn and two stalks of beans, 48.1 bushels of corn and 2.6 bushels of beans; three stalks of corn and three stalks of soybeans, 41.0 bushels of corn and 4.4 bushels of beans.

Odland (7), in West Virginia, observed that with corn planted in hills 30 inches apart, two stalks of corn and one of soybeans in a hill gave a yield of 33.4 bushels of corn. With the same amount of corn and two bean plants to the hill, the yield was 33.1 bushels of corn per acre. This was an average of a five-year period. The difference is probably not significant.

Louisiana Experiments

The Louisiana experiments with the rate of seeding soybeans in corn were conducted under conditions similar to the other local experiments discussed previously, except that they were conducted on rather fertile Mississippi River alluvial land. Yellow Creole corn and Otootan soybeans were used. This variety of corn is similar to the variety used in the other tests, except for the color. A rate of seeding of 10, 15, and 20 pounds of beans per acre was used. The corn was in rows four feet apart, and in hills 27 inches apart, two stalks to the hill. The beans were planted in the corn row when the corn was planted. The corn yields were considerably higher than the yields in the bench land tests previously discussed. This difference was due principally to the richer soil here. The soybeans also grew well, covering the ground in the middle completely.

Table 5 gives data on yields of the rate of seeding experiment for the five-year period that it was run. The corn stover weights were taken when the corn was ready for the silo. Soybean weights were taken at the same time. The corn grain weights were not taken until the ears were thoroughly dry.

Table 5. Rate of Seeding Soybeans in Corn

Rate of Seeding	Year	Bushels of corn per acre	Pounds of corn stover per acre	Pounds of Soybean vines per acre
Ten Pounds Beans Per Acre	1929	63.0	*	15,400
	1930	48.4		17,000
	1931	63.9	23,656	7,000
	1932	*	20,460	12,899
	1933	72.3	23,980	7,752
	Average	61.9	22,699	12,010
Fifteen Pounds Beans Per Acre	1929	63.7		14,550
	1930	44.5		18,632
	1931	59.6	24,187	10,070
	1932		20,900	13,688
	1933	67.6	21,418	9,656
	Average	58.8	22,168	13,315
Twenty Pounds Beans Per Acre	1929	62.1		13,750
	1930	46.1		19,312
	1931	58.7	23,843	12,800
	1932		19,910	14,713
	1933	65.9	23,489	8,840
	Average	58.2	22,414	13,883

* No corn stover weights were taken in 1929 and 1930. No corn grain weights were taken in 1932.

From the data given in Table 5 it appears that the difference in rate of seeding was not sufficient to make any significant difference in corn yields or in yield of corn stover. Had the range in rate been greater, the land less fertile, or the supply of moisture more scanty, the difference in effect would doubtless have been greater. The difference in the rate of seeding the soybeans does appear to have had a consistent effect on the weight of the soybean vines. This is in accord with expectations. An increase in the number of plants would naturally be followed by greater weight.

Effect of Soybeans on the Following Crop of Corn When the Beans Are Cut for Hay or When Plowed Under

A considerable amount of experimental work has been done to determine the effect of various legumes on the growth of the following crop when cut off for hay, or when plowed under. Most of the work has been done with the clovers and alfalfa, but during recent years soybeans have been used considerably in the experiments.

Mooers (9), of the Tennessee Experiment Station, obtained a yield of 27.1 bushels of corn per acre when the corn was grown continuously, a yield of 35.5 bushels where the corn followed a crop of beans that were removed for hay, and 39.7 bushels after the beans were turned under. These figures were an average from a six-year experiment.

In 1922, McClelland (10), at the Arkansas Experiment Station, found that plowing under soybeans increased the yield of corn 12 per cent over removing for hay. In 1924, it gave an increase of 16 per cent.

Uhland (11), at the Missouri Experiment Station, estimated from his experiments with soybeans that a crop turned under as green manure added about 70 pounds of nitrogen to the soil; when beans were cut for hay and manure returned to the soil, 30 pounds; when harvested for seed by use of a combine harvester (all plant parts returned except seed), there was a loss of about 4 pounds of nitrogen per acre; and when harvested for seed in the usual way (only roots and part of the leaves left on the land), a loss of about 28 pounds of nitrogen per acre.

At the Ohio Experiment Station, as mentioned by Morse (12), it was considered that the stubble and roots left after hay was removed had only 10 per cent of the weight of the hay and contained 6 pounds of nitrogen per acre. The hay removed contained 128 pounds of nitrogen.

From the figures given in the two cases just mentioned, it appears that if soybeans are cut for hay, they will not increase the fertility of the soil. In a number of cases it has been observed, however, that soybeans removed for hay did enrich the soil, as shown by increased yields of the following crop. Morse (12) mentions that at the Virginia Station wheat, following a crop of soybeans that had been removed for hay, gave an increase of 3.5 bushels per acre, and when the entire crop of soybeans was turned under as green manure, a further increase of 6.6 bushels.

Andrews, of the Mississippi Station, found that when Otootan soybeans were grown in white sand in pots in a greenhouse the roots weighed 23.4 per cent as much as the tops, and when grown in sandy loam soil under otherwise like conditions, the roots weighed 24.3 per cent of the tops. The percentage of nitrogen in the roots ran higher than in the tops in both cases. The percentage of roots obtained by Andrews is higher than is ordinarily estimated, but the writer is inclined to think that it is probably more nearly correct. If the plants are grown in pots, the whole root system is obtained, but if grown in a field, this is practically impossible.

A limited amount of study of soybean root systems in the soil has indicated to the writer that they are more extensive than is generally thought. Figure 6 shows a part of the root system of an Otootan soybean plant that we excavated. This plant was wide spaced so that the roots could be traced with a certainty. If other plants had been nearby, there would have been a mixing of root

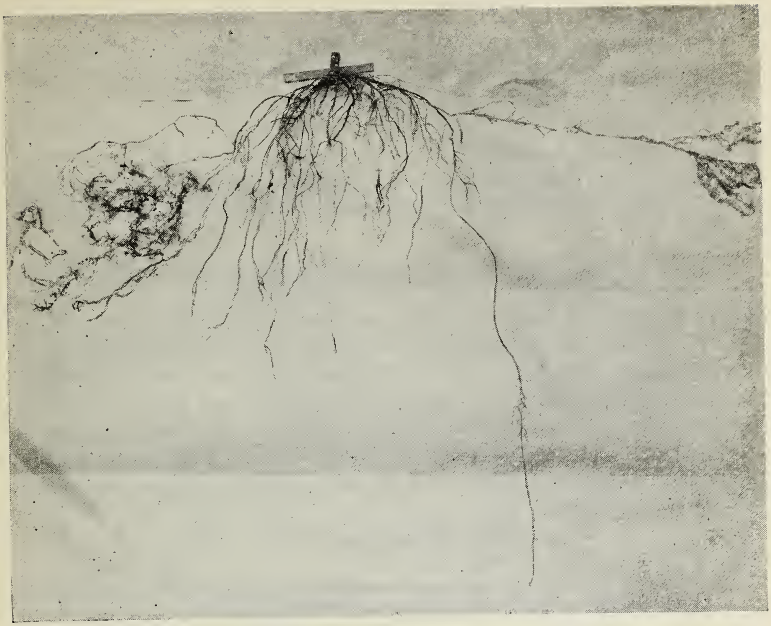

Figure 6
Soybean root system.

systems and confusion. The plant was grown on rather fertile alluvial land and attained a height of about four feet and a spread of approximately four feet. In the excavation, only a part of the roots were traced out, although a hole "apparently" nearly large enough to bury a haystack was dug. Enough work was done to show that the root system was extensive, that it had a lateral spread of more than eight feet, and that some of the roots penetrated the soil to a depth of six feet. (The foot ruler shown by the plant stem in Figure 6 will serve as a measure in judging the spread of the root system.) It seems certain that the total mass of roots, when the plant approaches maturity, is considerable. Probably an additional quantity of organic or chemical material, in the case of nitrogen, has been placed in the soil by the decay of root tubercles and tender parts of the roots during the growth period of the plant.

Louisiana Experiments

The Louisiana experiments to determine the effect of soybeans on soil fertility when cut off for hay and when turned under were started on bench land soil in 1929. There were twenty one-row plats for each of three treatments. The general conditions of the experiment were about the same as outlined on the first pages of this bulletin. In 1929, one-third of the plats were planted in corn, while the rest were planted in Otootan soybeans; 4263 pounds of hay per acre were grown. The beans on one-half of the bean plats were cut for hay and were turned under on the other half. In 1930, all the plats were planted in corn. The corn yields were used as measure of the soil fertility. In 1931, the plats that had been in beans were again planted in beans, and so on, a rotation being used each year. The corn plats that were used as a check were allowed to lie fallow in 1933.

Table 6, which follows, gives the individual plat yields for the entire experiment, the average number of plants for each plat, the bushels of corn per acre for each treatment, and the percentage of gain in yield for the different treatments. In 1934, the yields were reduced on all the plats by the tropical storm on June 16 which damaged the plants. The number of mature corn plants per plat averaged very nearly the same if the whole period of the experiment is considered. The figures ran as follows: plats with beans turned under, 48.9; plats with beans cut for hay, 48.3; plats without beans, 47.6

Discussion

As has been mentioned previously, soybeans ordinarily grow large when grown in Central and South Louisiana. This, coupled with the fact that lack of nitrogen is the chief limiting factor to crop production on much of the land, will probably help account for the decidedly beneficial results that were obtained from the use of soybeans. In states where the bean plants attain a height of 12 to 18 inches, the harmful effect on the current crop of corn is not so great when the beans are planted in the corn, but the beneficial effect is not so great.

Planting soybeans in late corn, that is, in corn planted after the first of June, has not proven very satisfactory in our tests at Baton Rouge. The beans germinated and started growth, but did not attain much size. In no case have beans made good growth when they were planted after the corn had come up. This has been especially true of beans planted after the corn was laid by. If planted after the corn plants have become large, the seed may germinate well, but the young tender plants cannot meet the competition of the large corn plants. They usually make rather feeble growth for a time, then a little later many plants die. However, in some areas soybeans planted in the middle of wide rows, say 5 or 6 feet wide, may make fair growth, provided the beans are not planted until the corn is getting past the stage when it takes a large amount of water from the soil.

Different varieties of soybeans vary somewhat in their harmful effect on the corn in which they are planted, and in their beneficial effect on the soil. The early dwarfish varieties, like Ito San, do not harm the corn so much, but, on the other hand, do not benefit the

Table 6. Corn Yields after Soybeans were Turned Under or Cut for Hay

Plat Weights of Corn Grain in 1930

	Plats with beans turned under			Plats with beans cut off for hay			Plats that grew no beans		
Series 1	14.7	17.7	19.0	15.2	13.4	17.3	11.1	12.4	14.8
Series 2	19.1	20.3	18.4	20.0	17.8	17.2	11.2	11.5	14.9
Series 3	16.5	16.9	18.2	12.1	13.1	14.0	13.6	10.5	12.3
Series 4	25.5	25.2	24.5	15.5	14.3	16.9	14.2	12.2	13.8
Average No. plants per plat	------	------	56.0	------	------	53.8	------	------	51.3
Bushels per acre	------	------	30.5	------	------	24.1	------	------	19.6
Per cent gain from beans	------	------	55.6	------	------	22.9			

Plat Weights of Corn Grain in 1932

	Plats with beans turned under			Plats with beans cut off for hay			Plats that grew no beans		
Series 1	34.7	32.1	35.3	25.3	21.1	22.8	15.2	19.3	20.2
Series 2	32.5	31.5	34.1	26.7	19.2	26.5	9.4	11.0	11.8
Series 3	29.5	28.5	28.1	15.1	15.2	15.2	10.0	9.0	11.5
Series 4	34.7	33.7	35.6	25.5	22.1	24.4	10.1	10.2	11.3
Average No. plants per plat	------	------	45.8	------	------	44.2	------	------	48.2
Bushels per acre	------	------	50.2	------	------	33.3	------	------	19.1
Per cent gain from beans	------	------	162.3	------	------	74.3	------	------	------

Table 6. Corn Yield after Soybeans were Turned Under or Cut for Hay—Continued

Plat Weights of Corn Grain in 1934

	Plats with beans turned under			Plats with beans cut off for hay			Plats that grew no beans		
Series 1	11.7	12.8	15.3	13.8	12.4	13.5	8.1	8.0	9.6
Series 2	10.3	14.0	12.9	13.1	13.9	15.3	4.3	5.8	7.9
Series 3	12.3	13.6	12.6	11.4	8.3	8.5	4.6	7.1	6.1
Series 4	16.2	13.2	18.8	14.5	13.7	13.7	7.2	5.5	8.1
Average No. stalks per plat	------	------	45.1	------	------	47.0	------	------	43.3
Bushels per acre	------	------	21.0	------	------	19.5	------	------	10.6
Per cent gain from beans	------	------	98.1	------	------	83.9	------	------	------

The data given in Table 6 show unusual benefit from the growing of soybeans as a means of increasing soil fertility. The percentage of gains, especially on the plats where the beans were cut off for hay, is greater than most investigators have obtained in similar experiments. Why this was true is not easily explained. The results seem to be reliable, for the land used was fairly uniform, several replications were used, and the number of corn plants per plat, considering the whole period of time, was as nearly uniform as any one could ever hope to have in an experiment of this type. The difference was not due to the reduction in fertility of the check plat, because there was not much lowering in yield. The drop in 1934 was due to the storm mentioned previously and affected all the plats alike.

soil like Ototan, a variety that makes heavy growth. At West Point, Mississippi, Akers and Westover (8) studied the effect of three prominent southern varieties of soybeans: Laredo, Otootan, and Biloxi. The effect of these three varieties did not differ greatly. When planted in corn the Laredo produced 1.37 tons of hay, and the corn made 13.19 bushels of grain per acre; the Otootan made 1.36 tons of hay, and the corn, 16.68 bushels; the Biloxi made .79 tons of hay, and the corn, 17.95 bushels. It is probable that in their test there were better bean stands in the Laredo than in the others. The Laredo plants have a much smaller habit of growth than the Biloxi, and some smaller than the Otootan.

In our experiments the Otootan variety, or other varieties of like type, were used exclusively. This type was considered best for planting in corn because the plants make heavy growth and spread out over the middle between rows to keep down grass and weeds.

Questions are frequently asked as to the relative value of soybeans, velvet beans, cowpeas, and mung beans for planting in corn. Here, as was mentioned in a previous paragraph, both the harmful and beneficial effects are largely in proportion to the amount of plant growth made. The Arkansas Experiment Station reports that cowpeas planted in corn caused a loss of 24.4 per cent corn grain; soybeans, a loss of 25.1 per cent; velvet beans, a loss of 21.8 per cent, and mung beans, 18.5 per cent. The heavier the legume seeding, the heavier was the loss. The increase in the following crop the next year was very nearly proportional to the losses the year the legumes were grown.

Mung beans make such light growth and are so susceptible to certain leaf diseases that, in respect to value, they are hardly in the class with the other legumes mentioned.

If cowpeas make good growth in corn when planted at lay-by time, they are an excellent legume for planting in corn. They do not harm the corn appreciably if planted then and they add much fertility to the soil. In some areas diseases affect them so badly that they are not satisfactory.

Velvet beans will probably make better growth on very poor land than any of the other legumes mentioned and they afford good winter grazing for cattle. They are objectionable in that they vine over the corn and tend to pull much of it down thus increasing the amount of rotten corn.

It is usually easier to get a good stand of soybeans than of the other legumes mentioned. They make good growth and are not bothered by insect and fungus diseases. Soybeans do well under a wide variety of conditions, but the actual choice of the legume to use should be determined by the needs and special conditions of the region.

SUMMARY

1. The corn and soybean experiments discussed were conducted under rather humid conditions and on moderately fertile soil.

2. Cocke's Prolific corn and Otootan soybeans, or similar varieties, were used in the tests. They are vigorous, rank-growing varieties.

3. The soybeans planted in the row of corn when the corn was planted invariably made good growth. They lowered the corn grain yield 19.1 per cent the first year, 33.6 per cent the second, but increased it 12.7 per cent the third, 51.7 per cent the fourth, and 35.2 per cent the fifth.

4. The soybeans grown in the corn plats just mentioned gave an average yield of 3108 pounds of dry soybean hay per acre.

5. The soybeans decreased the weight of corn stover the first years of the experiment, but increased it the later years. In 1933, the last year, there was an increase of 31.8 per cent.

6. The soybeans grown in corn on the land for four years increased the amount of organic matter in the soil 0.176 per cent, and the total nitrogen present, 0.0088 per cent.

7. If both corn and soybeans are to be grown, it is more economical to grow them both on the same land rather than on separate acres. When grown separately, the average production per acre was 20 bushels of corn and 3089 pounds of dry bean hay, but when grown in combination, the production per acre was 33.9 bushels of corn and 4020 pounds of hay.

8. With the same number of stalks per acre (both corn and soybeans) there was but little difference in yield between alternate row and "every row" planting. The differences were hardly significant most years. Under very favorable conditions for growing corn, the "every row" planting appears to give the best results, while under unfavorable conditions, the alternate row plan seemed to be best.

9. Alternate row planting is better for harvesting both the corn and the hay.

10. Varying the rate of soybean seeding in corn gave no consistent difference in corn production, either grain or stover, but an increase in rate of seeding did increase the weight of soybean hay produced. Rates of 10, 15, and 20 pounds of soybeans per acre were used.

11. Turning under soybeans, on plats where they were grown alone, increased the corn production the following year by 55.6 per cent; 162.3 per cent at the end of the second rotation, and 98.1 per cent at the end of the third.

12. Plats on which the soybeans were grown alone and cut for hay gave an increase in corn yields the following year of 22.9 per

cent; an increase of 74.3 per cent the fourth year, the end of the second rotation, and an increase of 83.9 per cent at the end of the third rotation.

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JULY, 1935 LOUISIANA BULLETIN No. 266

Blackstrap Molasses and Corn-Soybean Silage for Fattening Steers

By
M. G. SNELL

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SUMMARY

PART I

The addition of molasses to dry rations—that is, to rations not containing silage—had no significant effect upon the digestibility of crude protein, ether extract, or crude fiber. The nitrogen-free extract and the ash digestibility were increased significantly, except in the case of nitrogen-free extract in trial V, 1930-31, which was lowered. These increases were probably due to the molasses adding N. F. E. (sugars) and ash in a highly digestible form and not to any effect on the digestibility of the N. F. E. and ash of the other ingredients of the ration. The decreased digestibility of N. F. E. in trial V, 1930-31, was probably due to an excess of sugars, as this ration contained 57.81 per cent molasses. Adding molasses to a dry ration did not affect significantly the nitrogen balances of those rations.

Adding molasses to a dry ration did, however, increase the ash calcium, and magnesium balances but did not affect the phosphorous balance. The figures presented in the balance tables are indicative of a low ash and calcium intake in the basal rations.

Adding silage to the dry ration had no significant effect upon the digestibility of the nutrients except to lower the digestibility of ash.

Addition of molasses to a silage ration lowered the digestibility of crude protein but increased the digestibility of the ether extract and ash.

Addition of molasses to a silage ration lowered the nitrogen balance, indicating a lowered utilization of nitrogen or protein.

PART II

1. Satisfactory gains were made with rations of ground whole ear corn, cottonseed meal, and grass hay.

2. The addition of corn-soybean silage to a ration of ground whole ear corn, cottonseed meal, and grass hay increased the gains one year and decreased them the following year. The corn-soybean silage used the second year was of poor quality, which may account for its poor results.

3. The addition of molasses to both rations; i. e., ground whole ear corn, cottonseed meal, and hay or ground whole ear corn, cottonseed meal, hay, and silage, resulted in an increased consumption of hay and better cleaning of the feed, showing that molasses stimulated the appetite.

4. From a monetary standpoint, molasses when fed in a dry ration had about 94 per cent the value of ground whole ear corn; when fed in a ration with silage, it had about 87 per cent the value of ground whole ear corn.

BLACKSTRAP MOLASSES AND CORN-SOYBEAN SILAGE FOR FATTENING STEERS

M. G. SNELL

INTRODUCTION

Cane molasses or "blackstrap" is one of the by-products of the sugarcane industry. It is the low grade sirup from which most of the crystallizable sugar has been removed. Much of the mineral matter, resins, etc., are concentrated in this residue in the extraction of sugar. Louisiana alone produces about 11,621,000 gallons, or 67,982 tons annually, much of which is available for livestock feeding. The above figures are a five-year average blackstrap production for Louisiana for the years 1929 to 1933 inclusive.

The feeding of cane molasses or blackstrap to livestock in Louisiana is probably as old as the sugarcane industry in the state. Molasses has been fed to livestock, chiefly for fattening cattle, at various agricultural experiment stations in recent years, but as yet information as to its most economical use is lacking. Many stations have obtained conflicting results when molasses has been used in the ration, having secured good results with some rations and poor results with others.

The Louisiana Agricultural Experiment Station started an experiment in the fall of 1929, the object of which was to get additional information on molasses as a feed for fattening cattle. This project had two major parts; i.e., the study of (1) the effect of molasses upon the digestibility of cattle rations, and (2) the effect of including molasses in the ration of fattening steers upon their rates of gain.

REVIEW OF LITERATURE

Henry and Morrison (1922) state that "blackstrap" molasses, when fed in moderate amounts, is about equal to corn, pound for pound, for horses, dairy cattle, sheep, and fattening steers. According to these authors, molasses should not furnish more than one-half of the total concentrates fed in a beef ration. They say that it is only mildly laxative and seems to exert a healthful effect on the animal, but that is should be fed in a well-balanced ration. Thinning the molasses with water and pouring it over hay or silage is indicated as the preferred method of feeding.

Burns, of the Texas Experiment Station, as reported by Henry and Morrison (1922), fed molasses to 2-year-old steers for a period of 120 days. Six and one-half pounds of molasses replaced with good results a similar amount of corn when the basal ration was composed of shelled corn, cottonseed meal, and cottonseed hulls. The molasses-fed steers made slightly greater gains and required less feed per 100 pounds gain.

McCampbell and Winchester (1920), of the Kansas Experiment Station, found cane molasses to compare favorably in feeding value with corn for steer feeding when substituted for shelled corn in a ration of shelled corn (limited), linseed oil meal, cane silage, and alfalfa hay. The average amount fed in this case was 2.07 pounds per steer daily.

Trowbridge (1924), of the Missouri Station, found the addition of one pound of cane molasses to a ration of shelled corn, linseed oil meal, corn silage, and alfalfa hay fed to 2-year-old steers resulted in increased gains. .In this case, 100 pounds of molasses were equivalent to 46.9 pounds of shelled corn, 9.4 pounds of linseed oil meal, 6.3 pounds of alfalfa hay, and 175 pounds of silage.

Templeton and Goodell (1927) report four years' results of molasses feeding to yearling and 2-year-old steers. The basal ration was cottonseed meal, silage, and Johnson grass hay. In addition, one lot received an average of 2.57 pounds of molasses daily per steer, and another lot 5.15 pounds daily per steer. In the "light" molasses group, 100 pounds of molasses were equivalent to 13.2 pounds of cottonseed meal, 197.1 pounds silage, and 8.5 pounds hay. In the "medium" molasses ration, 100 pounds of "blackstrap" were equivalent to 9.6 pounds of cottonseed meal, 144.9 pounds silage, and 10.6 pounds of hay. The results are the most consistent, one year with another, that the author has reviewed. It may be that molasses is particularly adapted to this type of ration.

Quesenberry (1929), of the Iberia Livestock Experiment Farm (U. S.), Jeanerette, Louisiana (1925), found that the addition of 2.86 pounds of molasses daily to a ration of corn silage, and cottonseed meal fed to 2 year old steers resulted in increased daily gains, but at an increase in the feed required for a 100 pound gain. This same station (1926-27) the following two years found that the addition of two pounds of molasses to a ration of corn, soybean silage, and cottonseed meal decreased the daily gains and increased the feed required to produce a 100 pound gain. In other words, blackstrap had a negative feeding value.

Evvard and Culbertson (1921) added cane molasses at the rate of one, three, and five pounds per head daily to the rations of 2-year-old steers, the basal ration being shelled corn linseed oil meal, corn silage, and clover hay. In this test 100 pounds of molasses had a feeding value equivalent to 244, 106, and 123 pounds of corn, respectively, for the three lots. The following year a duplicate test was run, but in each case the value of cane molasses was less than that of shelled corn, pound for pound.

Culbertson et al (1929) reported two years' work on molasses for fattening calves. In the 1926-27 trial two lots of calves averaging 436 pounds per lot received shelled corn, linseed oil meal, alfalfa hay, and salt for 150 days. For the next 120 days one lot received approximately one pound of cane molasses per steer daily. The molasses-fed steers ate practically as much corn and linseed oil meal as the other group, and the molasses in addition, but gained less. Roughly, 100 pounds of molasses and 31.5 pounds of corn were equivalent to 63.2 pounds of alfalfa hay. The following year, 1927-28, two lots of calves averaging 381 pounds per lot were fed shelled corn, linseed oil meal, corn silage, a mineral mixture, and block salt for 150 days. During the next 90 days, one lot of calves had access to molasses in a self-feeder. The average daily gain of the two lots was practically the same, being 2.31 and 2.33, respectively, for the check and molasses-fed lot. Again the molasses-fed group ate almost as much as the check lot. In this case, 100 pounds of molasses were equivalent to approximately 25.8 pounds of corn.

Templeton (1925) fed "blackstrap" to hogs for a period of 98 days: the first 30 days in dry lot, and the remainder of the period on pasture. In this test 100 pounds of molasses were equivalent to 8.0 pounds of corn and 12.2 pounds of tankage.

Nelson, Keller, and Fulmer (1925) found cane molasses to be an excellent source of vitamin B. Their work also indicates the presence of a reproductive vitamin.

Williams (1925) tested the effect of cane molasses on the digestibility of complete ration when fed to dairy cows. Three experiments of three digestion trials, or a total of nine digestion trials, on each of four Holstein cows were run. The basal ration consisted of corn meal, wheat bran, ground oats, linseed oil meal, peanut meal, gluten meal, hay, silage, and salt. In the second trial, 15 per cent, and in the third trial 25 per cent cane molasses was added to the basal mixture. The effect was a slight lowering of the digestibility of the crude protein. The digestibility of the dry matter, ether extract, crude fiber, and nitrogen free extract seemed unaffected.

Skinner and King (1916) found that the addition of molasses to a ration of shelled corn, cottonseed meal, clover hay, and corn silage for lambs resulted in an increased daily gain, with less feed required per 100 pound gain.

Evvard, Culbertson, and Wallace (1923) in a lamb feeding trial compared a ration of shelled corn, full-fed, linseed oil meal 0.15 pounds daily, corn silage 1.504 daily, and legume hay 0.180 pounds daily with similar rations but received approximately 0.25 pounds, 0.50 pounds, and 0.75 pounds molasses daily. They conclude from this work that for fattening lambs molasses has a feeding value of from 10 to 15 per cent less than shelled corn.

Sheets (1928) states that satisfactory results have not been obtained in a number of experiments and suggests the possibility that these poor results may be due to factors other than the combination of feeds or the amount of molasses fed. He suggests the value of chemical analysis in helping to solve this problem.

Tomhave and Severson found molasses to have a lower feeding value than corn when fed at the rate of 5 pounds per head daily to steers receiving corn, mixed hay, corn silage, and cottonseed meal. However, Tomhave, Mackenzie, and Bentley found molasses to be worth more than corn when fed at the rate of 3.7 pounds to steers on a similar ration.*

Dalrymple (1906) found on collecting data from 47 Louisiana plantations that an average of 9.5 pounds of cane molasses was fed daily to work mules.

Brintnall (1921) replaced corn grain with molasses, pound for pound, in the ration of dairy cows and found the molasses fully equivalent to corn grain in the production of milk and butterfat and in the maintenance of body weight. The same author, in working with dairy calves, found molasses to be equal to corn as a feed for growing dairy calves. In this work, from two to five pounds of molasses were fed to each cow daily, and one pound of molasses was given each day to the calves, the molasses being mixed with other feeds.

Gerlaugh (1930) found that: (1) Blackstrap molasses has an appetizing effect, causing an increased consumption of feed; (2) blackstrap molasses contains a factor which stimulates growth; (3) two pounds of blackstrap have a feeding value equivalent to approximately two pounds of shelled corn when fed to fattening calves so as to replace an equivalent amount of shelled corn in the ration; (4) when fed at the rate of two and four pounds per calf daily, calves would consume these amounts in addition to their corn, and make only slightly more gain than calves on shelled corn; (5) four pounds of molasses when fed in addition to shelled corn produced only slightly greater gains than two pounds of molasses, showing that as the amount of molasses in the feed increased, the feeding value of the molasses decreased.

Snell and Taggart (1932) found blackstrap molasses (1) to be equivalent to corn grain as a feed for farm work mules and (2) to increase the appetite of farm work mules.

Peters (1933) reports work with fattening steers in dry lot when blackstrap molasses was used as a part of the grain ration. In the first of these trials, 2.5 pounds of molasses were not equivalent to 1.5 pounds of linseed meal when fed with corn and alfalfa hay. When fed with corn, linseed meal, and alfalfa, molasses had almost a negative feeding value. A daily consumption of 2.53 pounds of molasses in addition to the other feeds decreased gains. Self-feeding molasses resulted in a daily consumption of 436 pounds of molasses and an increase in daily gain. In the second year's results, two pounds of molasses were fed so as to replace two pounds of shelled corn, but proved to have a lower feeding value than shelled corn.

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*Reported by Henry and Morrison—"Feeds and Feeding". Page 479.

Bohstedt (1933) reports feeding trials with dairy cows, fattening steers, fattening lambs, and growing fattening pigs, in which cane molasses replaced 10 per cent of corn in the grain mixture. In all cases except one (self-fed lambs), the rations containing molasses required more feed to produce 100 pounds of gain than did the rations containing no molasses. Molasses was worth less then shelled corn.

Calloway (1921) fed as much as two pounds of molasses, together with skim milk and grain mixture, to young dairy calves and obtained good results.

For a period of 112 days Edwards and Massey (1934) fed three lots of steers averaging about 600 pounds. Lot I received a full feed of shelled corn; lot II had one-fourth of its shelled corn (3.31 pounds) replaced by an equal amount of molasses; lot III had one-half of its shelled corn (6.62 pounds) replaced by an equal amount of molasses. Each lot received 2.50 pounds of cottonseed meal, 6 pounds of cottonseed hulls, and 0.12 pounds of mineral mixture for each steer daily. The average daily gains were: lot I, 2.36 pounds; lot II, 2.28 pounds; and lot III, 1.99 pounds. In producing gains, 100 pounds of shelled corn were equivalent to 114 pounds of molasses, 2.7 pounds of cottonseed meal, and 6.6 pounds of hulls in lot II, or 136 pounds of molasses, 6.8 pounds of cottonseed meal, and 16.4 pounds of hulls in lot III. From these figures, it is seen that molasses when fed as in lot II has a feeding value somewhat less than 88 per cent of corn, and as fed in lot III, less than 74 per cent of shelled corn.

Neale (1932) found cane molasses to increase the rate of gain, eliminate death losses, and to increase the general health and appearance of lambs getting cottonseed meal and cottonseed hulls.

Lantow (1933) found cane molasses to be palatable and to increase the consumption of feed when added to the ration of fattening steers.

PART I

DIGESTION TRIALS WITH MOLASSES

1929-30 RESULTS

Inasmuch as the review of literature showed quite variable results with molasses, it was thought that molasses might affect the digestibility of the ration; hence, digestion, rather metabolism trials, were started with steers to determine the effect of molasses upon the digestibility of rations.

Three yearling steers were used for the metabolism trials. The rations were fed 14 days before beginning the collection of feces and urine. The trial proper was of 10 days' duration, during which time records were made of feed consumption, weighback, feces, urine, and of gain or loss in weight. All chemical analyses were made by the department of Chemistry of the Louisiana Agricultural Experiment Station.

The rations fed during the first year are shown in table I.

Table I. Daily Rations Fed Digestion Steers, 1929-30

Trial	I	II	IV	V	VI
	pounds	pounds	pounds	pounds	pounds
Corn, ground whole ear	6.00	3.00	8.00	5.00	10.00
Molasses	------	2.10	------	2.09	2.09
Cottonseed meal	2.00	2.00	2.00	2.00	2.00
Hay	2.78	4.38	1.87	2.75	1.36
Silage	------	------	4.20	8.00	6.13
Total	10.78	11.48	16.07	19.84	21.58
Per cent molasses	0.	18.287	0.	9.634	9.88
Nutritive ratio	6.09	6.66	6.02	7.18	9.29

In setting up these trials an attempt was made to duplicate feed lot conditions, yet maintain a sound scientific proceduce. For example, when the steers were on trial II, they received the same rations as they had when they were on trial I, except that 2.10 pounds of molasses replaced an equivalent amount of corn grain (as ground whole ear corn). The steers consumed more hay during this trial. In trial IV corn-soybean silage was substituted for part of the hay. In trial V molasses was fed so as to replace an equivalent amount of corn grain as fed in trial IV. In trial VI the steers were allowed to consume all the ground whole ear corn, hay, and silage that they would, only the cottonseed meal and molasses being kept at a constant level.

From the feed consumed and the analyses of the feed and weighback, the percentage composition of the feed consumed was calculated. These calculated analyses are given in table II.

Table II. Calculated Chemical Composition of the Rations as Consumed by the Steers, 1929-30

Ration	Per cent molasses	Crude protein	Ether extract	Nitrogen free extract	Crude fiber	Ash
1	0	13.09	2.89	53.192	17.86	4.11
II	18.29	11.09	2.17	49.24	19.73	5.85
IV	0	9.96	1.76	42.28	12.98	2.95
V	9.63	7.70	2.05	39.09	11.57	3.34
VI	9.88	6.14	2.26	41.90	11.96	3.45

The digestion trial figures were subjected to statistical analysis (analysis of variance) and Snedecor's F values used to determine significance, an F value of 3.48 indicating significant variations and an F value of 5.99 indicating highly significant differences. The size of significant differences was then calculated. These figures are shown in table III.

Table III. Digestion Percentages of Rations, 1929-30.

Ration	Per cent molasses	Nutritive ratio	Crude protein	Ether extract	Nitrogen free extract	Crude fiber	Ash
I	0.	6.09	51.19	72.61	61.87	47.30	21.26
II	18.29	6.66	50.55	78.57	69.14	60.95	47.39
IV	0	6.02	53.34	63.10	59.68	48.16	13.66
V	9.63	7.18	39.83	83.68	61.69	37.33	27.96
VI	9.88	9.29	31.34	87.98	63.07	49.48	40.26
Snedecor F values			63.78	15.05	7.46	7.64	179.49
Significant differences			4.82	9.86	5.18	12.01	4.03
Highly significant differences			7.99	16.36	8.59	19.92	6.68

The F values all exceed 5.99, which means that highly significant variations occurred in the digestibility of all nutrients. An examination of table III shows which of these differences were significant. If these tests of significance are applied to each nutrient, the following conclusions appear justified:

Crude Protein—Adding either molasses or silage to a dry ration does not seem to affect the digestibility of the crude protein of the ration as a whole. Adding molasses to a ration containing silage lowers the digestibility of the crude protein, and this difference is highly significant.

Ether Extract—There was no significant difference in digestibility of the ether extract of rations I and II, showing that the addition of molasses to a dry ration did not affect the digestibility of the ether extract. Adding silage to corn, cottonseed meal, and hay resulted in a marked lowering of the digestibility of the ether extract; adding molasses increased its digestibility.

Nitrogen Free Extract—No significant differences existed in the digestibilities of nitrogen free extract of rations I, IV, V, and VI. The addition of 18.29 per cent molasses in ration II resulted in a significantly higher digestibility of the nitrogen free extract. The digestibilities of nitrogen free extract in rations V and VI were higher than in ration IV, indicating the tendency of molasses to increase the digestibility of N. F. E. These effects might result from the inclusion of molasses, inasmuch as the sugars in molasses are highly digestible; hence, an increase in the amount of molasses in a ration would increase the digestibility of the total N. F. E. without necessarily affecting the digestibility of the N. F. E. of the other portions of the ration.

Crude Fiber—The digestibility of the crude fiber varied widely, and these variations were significant statistically, yet their interpretation is difficult. Adding molasses (18.29 per cent) to a dry ration increased the digestibility of crude fiber; adding molasses to a silage ration (rations IV and V) decreased the digestibility in ration V, but the digestibility of crude fiber in ration VI, which contained molasses, was not affected.

Ash—Ash digestibilities varied widely. Adding silage to a dry ration decreased the digestibility of ash; adding molasses increased the digestibility of ash.

RESULTS FOR 1930-31.

The second year, the plan of digestion trials was changed somewhat. A basal mixture containing eight parts ground whole ear corn, two parts cottonseed meal, and four parts chopped grass hay by weight was made. This basal mixture was used in trial I. In trials II, III, IV, and V, molasses replaced corn grain in the basal mixture in the following percentages: 15 per cent, 30 per cent, 45 per cent, and 100 per cent.

Three steers were used in each digestion trial. Each trial was preceded by a 14-day preliminary feeding period followed by a 10-day collection period.

The calculated chemical composition of the rations consumed is shown in table IV. These calculations were made from the weights and analysis of the feed fed and the feed refused.

TableIV. Calculated Chemical Composition of the Rations as Consumed by the Steers, 1930-31.

Ration	Per cent corn grain replaced by molasses	Crude protein	Ether extract	Nitrogen free extract	Crude fiber	Ash	Per cent molasses
I	0	13.75	3.80	50.40	14.70	4.55	0
II	15	11.98	3.13	56.55	12.18	5.56	13.04
III	30	9.54	2.62	55.59	11.23	7.45	23.08
IV	45	9.55	2.11	55.21	11.24	7.91	31.58
V	100	10.08	1.85	49.74	12.16	12.25	57.81

The only significant variation in the digestibility of the crude protein occurred in trial II, when the steers were fed a ration in which 15 per cent of the corn grain had been replaced by molasses. In this trial, average digestibility of crude protein was 66.45 per cent, which was from 11 to 18 per cent higher than the digestibilities of the crude protein in the rations fed during the other trials.

The average digestibilities of the feed nutrients are shown in table V.

Table V. Digestion Percentages of Rations, 1930-31.

Ration	Nutritive ratio	Per cent corn grain replaced by molasses	Per cent molasses	Crude protein	Ether extract	Nitrogen free extract	Crude fiber	Ash
I	5.56	0	0	55.54	79.00	63.05	28.71	37.69
II	5.77	15	13.04	66.45	78.16	67.97	17.27	55.06
III	8.29	30	23.08	48.69	77.89	72.79	32.19	63.81
IV	10.66	45	31.58	48.45	76.02	73.90	35.71	68.26
V	8.75	100	57.81	48.34	68.13	42.49	29.76	71.66
Snedecor's F values				6.48	1.19	4.91	1.67	33.15
Significant differences				12.14	none	8.67	none	9.26
Highly significant differences				20.13	none	14.38	none	15.35

The F values in Table V show significant variations to have occurred in the digestibilities of crude protein, nitrogen free extract, and ash.

The digestibilities of the N. F. E. increased, with the increase in amount of molasses incorporated in the ration up to the 45 per cent level. When all the corn grain was replaced by molasses, the average percentage of digestibility dropped abruptly from 73.9 per cent (ration IV) to 42.49 per cent (ration V). The reason for this drop is a matter for speculation.

The digestibilities of the ash increased, with the increase in molasses. Whether or not a more highly digestible ash was being fed with the molasses or whether the molasses increased the digestibility of the other ash is not known. The ash column in table IV, "Calculated Chemical Composition of Rations as Consumed by the Steers, 1930-31", indicates that the molasses contains an ash which is more highly digestible than the ash of the basal ration; hence, the digestibilities of the ash are higher.

NITROGEN AND ASH BALANCES

Nitrogen balances were determined in the year 1929-30, and both nitrogen and ash balances were determined during the year 1930-31. In order to make them comparable one with another and from year to year, these balances have been calculated to 1000 pounds live weight basis.

Because the amount of nitrogen or crude protein consumed may affect the amount retained, table VI is presented.

Table VI. Crude Protein Consumption and Morrison Standards, per 1000 pounds live weight, over 10-day digestion period

Trial	Per cent molasses	Crude protein consumed, lbs.	Crude protein required by Morrison standards, lbs.	Average excess, lbs.
I	0	36.081	24.5	12.58
II	18.29	29.163	22	7.16
IV	0	36.156	22	14.16
V	9.63	33.369	22	11.37
VI	9.88	23.044	21	2.04

Table VI shows the amounts of crude protein fed in each trial to be greater than that required by the Morrison Standards; hence, some storage of crude protein might be expected. Table VII shows the nitrogen balances calculated to 1000 pounds for each digestion trial.

Table VII. Average Nitrogen Balances Calculated on the Basis of 1000 Pounds Live Weight, 1929-30.

Trial	Ration	Per cent molasses	Ten-day nitrogen average: Consumption, pounds	Ten-day nitrogen average: Balance, pounds
I	Dry	0	5.7732	1.4937
II	Dry	18.29	4.8660	1.7334
IV	Silage	0	5.7849	1.2668
V	Silage	9.63	5.3387	0.9036
VI	Silage	9.88	3.6874	0.1391

Average difference in N balance to be significant—0.336 pounds.
Average difference in N balance to be highly significant—0.557 pounds.

This table shows no significant difference in the storage of nitrogen during trials I and II in which no silage was fed. The inclusion of 18.29 per cent of molasses to a dry ration did not affect significantly the storage of nitrogen. A comparison of the balances of trials I and IV shows that the storage of nitrogen from the silage ration (trial IV) did not differ significantly from that of the dry ration (trial I). However, the addition of molasses to a silage ration, as fed in trials V and VI, resulted in a significant lowering of the nitrogen balances. Hence, it seems as though the protein of the molasses-silage rations was not utilized as efficiently as that of the dry ration, the dry ration plus molasses, or the silage ration.

The average nitrogen and ash balances for 1930-31 are shown in table VIII.

No significant differences occurred in the nitrogen balances or in the storage of nitrogen from the dry rations and dry ration plus molasses in the year 1929-30. Hence, these figures are in line.

The ash balances increased as the percentage of molasses in the dry ration increased. The storage of calcium and magnesium also increased with an increase of molasses in the ration, which raised the consumption of these two elements. Hence, this may have affected the retention of the two elements. Not only were the balances increased with the increase of molasses in the ration, but also the percentage of these elements retained in the body was significantly affected. These figures are shown in table IX.

Significant variations occurred in percentages retained of nitrogen, ash, calcium oxide, and magnesium oxide. No significant differences occurred in the percentage of phosphorus pentoxide retained.

The figures on percentage nitrogen retained might be construed to mean that the replacement of 15 per cent of the corn by a similar amount of molasses favored nitrogen retention and that the inclusion

Table VIII. Average Nitrogen and Ash Balances Calculated on Basis of 1000 Pounds Live Weight, 1930-31.

Trial	Per cent Molasses	Nitrogen		Ash		P_2O_5		CaO		MgO	
		Consumed	Balance	Consumed	Balance	Consumed	Balance	Consumed	Balance	Consumed	Balance
I	0	6.904	1.569	14.237	2.894	3.434	1.021	1.038	0.327	1.038	0.339
II	13.04	5.849	1.853	16.958	5.546	2.976	1.197	1.528	0.933	1.134	0.429
III	23.08	4.807	1.164	23.465	8.413	2.884	0.904	2.160	1.580	1.464	0.886
IV	31.58	4.698	1.092	24.341	8.897	2.442	1.018	2.390	1.907	1.489	0.849
V	57.81	5.002	0.819	38.278	14.682	2.068	0.197	3.779	2.649	2.241	1.305
Snedecor's F values*			2.59		10.397		1.89		8.93		4.64
Significant difference			none		5.323		none		1.189		2.245
Highly significant difference			none		8.828		none		1.972		3.723

F values* to denote significant variation must be 3.48 or more.

Table IX. Consumption and Retention of Nitrogen and Ash by Percentages, Calculated on Basis of 1000 pounds Live Weight, 1930-31.

Trial	Per cent Molasses	Nitrogen		Ash		P_2O_5		CaO		MgO	
		Consumed	Per cent retained	Consumed	Per cent retained	Consumed	Per cent retained	Consumed	Per cent retained	Consumed	Per cent retained
I	0	6.904	22.62	14.237	20.39	3.434	28.75	1.0383	29.65	1.038	32.12
II	13.04	5.849	31.53	16.958	32.13	2.976	39.07	1.528	60.70	1.134	38.15
III	23.08	4.807	21.92	23.465	36.15	2.884	31.78	2.160	73.05	1.464	72.56
IV	31.58	4.698	23.49	24.341	36.89	2.442	40.57	2.390	79.69	1.489	56.61
V	57.81	5.002	16.46	38.278	38.80	2.068	10.62	3.779	70.14	2.241	58.16
Snedecor's F values			9.84		3.84		2.66		40.02		7.76
Significant difference			6.58		15.27		none		12.21		19.52
Highly significant differences			10.91		25.33		none		20.25		32.42

of greater amounts of molasses had the opposite effect. However, the data are too few to draw conclusions.

Table X gives additional data on this point.

Table X. Crude Protein Consumption and Morrison Standards, per 1000 Pounds Live Weight—Over 10-Day Digestion Period

Trial	Per cent Molasses	Crude Protein Consumed Pounds	Crude Protein Required by Morrison's Standards Pounds	Excess Pounds	Per cent Retained
I	0	43.15	24.5	18.65	22.62
II	13.04	36.56	23.6	12.96	31.53
III	23.08	30.08	22.83	7.25	21.92
IV	31.58	29.35	22.83	6.52	23.49
V	57.81	31.26	21.3	9.96	16.46

The percentage of ash retained increased with the amount of molasses in the feed. Likewise the percentage calcium oxide increased with the increase in molasses in the ration except in ration V, in which instance all the corn was replaced by molasses. Whether molasses increased the ash and calcium retention or whether their retention was due to the fact that molasses increased the amount of ash and calcium oxide in the ration cannot be ascertained from the date. However, the latter seems more plausible, and the author is inclined to think that these steers did not ordinarily obtain the optimum amount of ash and calcium in their rations.

PART II

BLACKSTRAP MOLASSES AND CORN-SOYBEAN SILAGE FOR FATTENING YEARLING STEERS

Just when molasses was first fed to Louisiana livestock is not known. However, the use of molasses as a feed for livestock in Louisiana is probably as old as the industry in this state.

As the review of literature indicates, the value of molasses as a feed for cattle varies with the amount of molasses fed and the other feeds given with it. Rations ordinarily fed in the South include corn, cottonseed meal, hay, and silage. In order to get additional information on the value of molasses when fed with the above mentioned feeds, a two-year steer feeding experiment was started in 1929. These feeding trials covered 140 and 150 days, respectively. The rations fed are as follows:

Lot I. Ground whole ear corn, cottonseed meal, and hay.

Lot II. Ground whole ear corn, molasses, cottonseed meal, and hay.

Lot III. Ground whole ear corn, cottonseed meal, hay, and corn-soybean silage.

Lot IV. Ground whole ear corn, molasses, cottonseed meal, hay, and corn-soybean silage.

The ground whole ear corn as fed in this experiment included corn, cob, and shuck, and averaged 76 per cent grain. The molasses of lots II and IV was fed so as to replace an equivalent amount of corn grain in lots I and III. The ground whole ear corn and cottonseed meal were placed in the feed bunks and the molasses poured over the mixture. In lots III and IV, the silage was put in the feed bunks on top of the grain. The hay was fed in self-feeder racks in all lots.

First Feeding Trial—1929-30

The results of the first feeding trial are summarized in table VI, "Summary of Results of 140-Day Steer Feeding Trial, 1929-30".

The lot IV yearlings getting ground whole ear corn, molasses, cottonseed meal hay, and silage made the most rapid and the cheapest gains of any of the lots. Their average daily gain was 2.16 pounds per head, and the cost for each 100 pounds of gain was $9.65. The daily gains of the other lots were: lot I, 2.07 pounds; lot II, 2.01 pounds, and lot III, 2.12 pounds. The cost for 100 pounds of gain was: lot I, $10.23; lot II, $9.86, and lot III, $10.44.

Lot I demonstrated that satisfactory gains can be made with rations of ground whole ear corn, cottonseed meal, and mixed grass hay.

The feeding of 2.38 pounds of molasses in place of corn grain in lot II resulted in a decrease in average daily gain, but increased the hay consumption and the feed required for the 100 pounds of gain. One hundred and forty-one pounds of ground whole ear corn as fed in the lot I ration were equivalent to 118 pounds of molasses, 3 pounds of cottonseed meal, and 77 pounds of hay. On this basis molasses was worth 14.84 cents per gallon, or $25.20 per ton.

The addition in lot IV of 2.38 pounds of molasses in place of an equivalent amount of corn resulted in increasing the rate of gain and in an increase in the hay consumption as compared with lot III. In this case, 152 pounds of ground whole ear corn and two pounds of cottonseed meal as fed in lot III were equivalent to 110 pounds of molasses, 12 pounds of hay, and 302 pounds of silage in the lot IV ration. On this basis, blackstrap molasses was worth 14.13 cents a gallon, or $24.15 a ton.

A comparison of lots I and III shows the effect of adding corn and soybean silage to a ration of ground whole ear corn, cottonseed meal, and hay. The lot III steers made an average daily gain of

TABLE VI.

SUMMARY OF RESULTS OF STEER FEEDING TRIAL, 1929-30

10 Steers per lot fed October 25, 1929, to March 15, 1930—140 Days

TABLE BASED ON ONE AVERAGE STEER

LOT	I	II	III	IV
Rations Fed Flake Salt in All Lots	Gr. Whole Ear Corn, C. S. Meal Hay	Gr. Whole Ear Corn, C. S. Meal Molasses, Hay	Gr. Whole Ear Corn, C. S. Meal Silage, Hay	Gr. Whole Ear Corn, Molasses C. S. Meal, Hay Silage
Initial weight, lbs.	428	431	430	426
Final weight, lbs.	718	712	727	728
Daily gain, lbs.	2.07	2.01	2.12	2.16
Daily feed, lbs.				
Gr. whole ear corn	9.26	6.14	9.30	6.15
Molasses	------	2.38	------	2.38
C. S. Meal	2.07	2.07	2.08	2.08
Hay	7.09	8.31	4.80	5.13
Silage	------	------	8.30	10.73
Feed required for 100 lbs. gain				
Gr. whole ear corn	447	306	438	286
Molasses	------	118	------	110
C. S. Meal	100	103	98	96
Hay	337	414	226	238
Silage	------	------	391	498
Feed cost per 100 lbs. gain	$10.23	$ 9.86	$10.44	$ 9.65
Cost per steer @ 3c per lb.	12.74	12.93	12.90	12.78
Feed cost per steer	29.65	27.70	31.01	29.12
Estimated fixed costs	1.70	1.70	1.70	1.70
Labor costs	1.50	1.50	1.50	1.50
Total estimated costs	$45.59	$43.83	$47.11	$45.10
Necessary selling price per cwt. to break even at Baton Rouge	$ 6.35	$ 6.15	$ 6.48	$ 6.20

Prices of feed:

Gr. whole ear corn	$1.4260	per cwt.	$ 1.08	per bushel
Molasses	1.00	per cwt.	.117	per gallon
Cottonseed meal	2.00	per cwt.	40.00	per ton
Mixed hay	.60	per cwt.	12.00	per ton
Soybean hay	.60	per cwt.	12.00	per ton
Salt	1.00	per cwt.		
Grass hay	.50	per cwt.	10.00	per ton
Mineral mixture	2.00	per cwt.		
Silage	.25	per cwt.	5.00	per ton

TABLE VII

SUMMARY OF RESULTS OF STEER FEEDING TRIAL, 1930-31

October 15, 1930, to March 14, 1931—150 Days

10 Steers per Lot

TABLE BASED ON THE AVERAGE STEER

LOT	I	II	III	IV
Rations fed Block Salt in All Lots Mineral Mixture in All Lots	Gr. Whole Ear Corn, C. S. Meal Hay	Gr. Whole Ear Corn, C. S. Meal Molasses, Hay	Gr. Whole Ear Corn, Silage C. S. Meal, Hay	Gr. Whole Ear Corn, Molasses, C. S. Meal, Hay Silage
Initial weight, lbs.	380.	383.	378.	371.
Final weight, lbs.	658.	662.	643.	642.
Daily gain, lbs.	1.85	1.86	1.77	1.81
Daily feed, lbs.				
Corn, ground whole ear	11.90	9.21	11.14	9.21
Molasses	--------	1.98	------	1.95
Cottonseed meal	2.02	2.02	2.02	2.01
Hay, grass	2.10	3.43	1.42	2.79
Silage	--------	------	1.30	1.65
Feed required per 100 lbs'. gain				
Corn, ground whole ear	642	495	631	512
Molasses	------	106	------	108
Cottonseed meal	109	109	115	112
Hay, grass	113	184	80	155
Silage	------	------	73	91
Feed cost per 100 lbs. gain	$11.96	$11.28	$11.92	$11.65
Cost per steer @ 3c per lb.	11.40	11.48	11.34	11.12
Feed cost per steer	33.27	31.47	31.57	31.46
Estimated fixed costs	1.70	1.70	1.70	1.70
Labor costs	1.50	1.50	1.50	1.50
Total estimated costs	$47.87	$46.15	$46.11	$45.78
Necessary home price to break even at Baton Rouge	$ 7.26	$ 6.97	$ 7.16	$ 7.13

Prices of Feeds:

Ground whole ear corn	$1.4260	per cwt.	$ 1.08	per bushel
Molasses	1.00	per cwt.	.117	per gallon
Cottonseed meal	2.00	per cwt.	40.00	per ton
Silage	.25	per cwt.	5.00	per ton
Grass hay	.50	per cwt.	12.00	per ton
Salt	1.00	per cwt.	20.00	per ton
Mineral mixture	2.00	per cwt.	40.00	per ton
Mixed hay	.60	per cwt.	12.00	per ton
Soybean hay	.60	per cwt.	12.00	per ton

2.16 pounds as compared with 2.07 pounds daily for the lot I steers. Silage as fed in this trial and with feed values as given had a replacement value of $4.27 a ton.

A comparison of lots II and IV shows the effect of adding silage to a ration of ground whole ear corn, molasses, cottonseed meal, and hay. The addition of silage increased the rate of gain and decreased the feed cost per 100 pounds' gain. Under these conditions, silage had a replacement value of $6.27.

Second Feeding Trial—1930-31

The results of the second feeding trial are shown in table VII, "Summary of Results of Steer Feeding Trial, 1930-31".

Again satisfactory gains were made with a ration of ground whole ear corn, cottonseed meal, and grass hay.

The replacing of two pounds of corn grain by blackstrap molasses as fed in lot II resulted in a slight increase in gain, but also in an increase in hay consumption.

The addition of corn-soybean silage to the ground whole ear corn—cottonseed meal—hay ration as fed in lot III resulted in a decrease in the rate of gain. The silage fed this year was not of the best quality, and the consumption was low, which may have caused the lowered gains.

The addition of molasses to the silage ration, when fed as in lot IV, resulted in increased gains and feed consumption.

Molasses is apparently an appetizing feed. The steers in lots II and IV receiving two pounds of molasses daily cleaned their troughs daily, while the steers in lots I and II were inclined to leave feed in their troughs. The hay consumption in lot II was greater than in lot I; the steers in lot IV ate more hay and more silage and had less feed left in their troughs than did the steers in lot III.

The increased gains of lots II and IV over lots I and III, respectively, were probably due to increased feed consumption.

One hundred pounds of ground whole ear corn plus 2.22 pounds of cottonseed meal as fed in lot I were equivalent to 73 pounds of blackstrap molasses and 71 pounds of grass hay as fed in lot II. On this basis, blackstrap molasses was worth 16.74 cents per gallon, or $28.61 per ton.

When lots III and IV are compared, 100 pounds of ground whole ear corn plus 2.7 pounds of cottonseed meal have an equivalent feeding value of 89 pounds molasses, 61 pounds of hay, and 15 pounds of silage. Under these conditions, molasses has a value of 14.15 cents per gallon, or $24.19 per ton.

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AUGUST, 1935 LOUISIANA BULLETIN NO. 267

A GENERAL SUMMARY OF EXPERIMENTS WITH SUGARCANE

Part I—By W. G. Taggart, C. B. Gouaux and E. C. Simon
Part II—By C. W. Edgerton, E. C. Tims and P. J. Mills
Part III—By W. E. Hinds and B. A. Osterberger

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATIONS
C. T. Dowell, Director

PART I

Work of the Sugar Experiment Station

By

W. G. TAGGART, C. B. GOUAUX, and E. C. SIMON

VARIETIES

For many years the average yield of sugarcane in Louisiana ranged between 16 and 20 tons. The state sugar crop averaged around 300,000 tons of sugar per annum. During the period, one general type of sugarcane was grown, the so-called "Noble" cane, characterized by a large stalk diameter, low fiber content, and a sucrose content satisfactory for sugar production under Louisiana conditions.

When varieties of the "Noble" type of sugarcane became infested with diseases, the yield of sugar per annum decreased, reaching a low of 47,000 tons of sugar in 1926. At that time it was generally believed that the Louisiana sugar industry was doomed; many sugarcane growers went out of business, either voluntarily or through bankruptcy.

Had it not been for investigational work, there is no question but that the sugar industry of Louisiana would have vanished. Through the introduction of hybrid types of sugarcane, which were known at that time to be tolerant toward the prevailing diseases so destructive to the "Noble" canes, a new start was made and the sugar industry saved. These canes, P. O. J. 234, P. O. J. 213, and P. O. J. 36, were not thoroughly satisfactory but served as a stop loss until, through intensive investigational work, better varieties were secured. Of the P. O. J. canes, the variety P. O. J. 234 became the most widely planted on account of its early maturity and high sucrose content. This variety produced fairly satisfactory yields of plant cane, but its stubbling qualities were very weak, resulting in an average yield of sugarcane in the state of about 15 tons per acre, a yield which was entriely too low to enable the farmer to realize a proper return on his investment.

Through intensive investigational work of the Louisiana Experiment Station at Baton Rouge and in its test fields throughout the state, in co-operation with the office of Sugar Plant Investigations, United States Department of Agriculture, three new varieties of sugarcane more suitable to Louisiana conditions were secured and given to the industry. When grown under conditions most suitable to each variety, these canes, C. P. 807, Co. 281, and Co. 290, were all capable of producing more satisfactory crops in the field than the P. O. J. varieties, and of yielding satisfactory factory returns. Of the three varieties, Co. 281 is most generally suitable to the different sections of the Louisiana sugar district; Co. 290 is especially adapted to the Teche area, Lafayette area, and portions of the Mississippi alluvial lands of the lower part of the Louisiana sugarcane district; C. P. 807 grows well in the same sections as Co. 290. The high fiber content and the excessive cost of harvesting, due to its type of growth, make C. P. 807 the least popular of the three varieties.

While the varieties, C. P. 807, Co. 281, and Co. 290, made the growing of sugarcane a safer venture, they did not fulfill all of the requirements that are necessary to bring back full recovery to the sugar industry. Through further investigational work the canes, C. P. 28-11, C. P. 28-19, and C. P. 29-320 varieties, scientifically bred at the United States Sugar Plant Field Station, Canal Point, Florida, were secured. All three of these canes are disease resistant, high in sucrose content, and heavy yielders in stubble crops—as rich or richer in sugar content of the juice as P. O. J. 234, but greatly surpassing this variety in tonnage per acre. Tests so far indicate that the tonnage per acre yields on the newer canes will be nearly as high as the tonnage obtained from our highest yielding commercial varieties, Co. 290 and C. P. 807, both of which are much lower in sucrose content that the three new canes.

In recent years it has become the custom to wait until October 15 to October 22 before beginning the grinding season. In a country where the cold hazard in late December or early January is as great as it is in Louisiana, this delay often proves very costly. The new variety, C. P. 29-320, has, for the past several years at Baton Rouge, shown a sucrose content that justifies our believing that when this cane comes under commercial cultivation, the sugar houses will be able to start their grinding operations not later than the first week in October. This will prove a double advantage: the first and most important advantage will be a reduction in the cold hazard; the second, an increase of approximately 20 per cent in the length of the grinding season.

The following two tables, based on results obtained at Baton Rouge, will serve to show the comparative merits of the above discussed varieties.

TABLE 1

Yield in Tons per Acre of Recently Introduced Cane Varieties.
(Tests at Baton Rouge.)

Variety	Plant	1st Stub.	2nd Stub.	4th Stub.	5th Stub.	6th Stub.
P. O. J. 234	23.34	18.33	3.54	**	**	**
C. P. 807	36.30	26.68	18.77	19.20	**	**
Co. 281	30.27	30.46	23.30	21.74	19.53	17.79
Co. 290	44.43	35.03	33.32	33.69	38.95	**

** Indicate no plantings.

TABLE 2

Field and Mill Data on Recently Introduced Cane Varieties
at Baton Rouge

PLANT CANE

Variety	Tons per Acre	Brix	Sucrose	Purity	Extraction
P. O. J. 234	23.34	15.80	12.43	78.67	71.43%
C. P. 28-11	29.11	17.40	13.42	77.13	67.57%
Co. 281	30.27	16.40	13.47	82.13	71.15%
C. P. 29-320	31.76	17.10	13.51	79.01	71.30%
C. P. 28-19	32.38	17.60	14.38	81.70	69.92%
C. P. 807	36.30	15.50	12.76	82.32	67.37%
Co. 290	44.43	15.80	11.90	75.32	73.76%

In Table 1 we find that P. O. J. 234 gave fairly satisfactory yields, both in plant cane and first stubble, but is definitely of no economic value as second stubble. On the other hand, the other three varieties are rendering good yields through fourth, fifth, and sixth stubble, where such stubble crops were obtainable. While there are no data on the yields of C. P. 807, fifth and sixth stubble, and Co. 290 sixth stubble, Co. 281 continued to give higher yields in sixth stubble than the state tonnage yield for all varieties.

Table 2 compares the tonnage yield and juice analyses of P. O. 234 plant cane with the newer varieties now under cultivation in Louisiana.

An important factor in the utilization of varieties is the rate at which they deteriorate (lose their sucrose content). This factor is very important, for it is entirely possible for a very high sucrose sugarcane to deteriorate to such an extent that it may become unpofitable to mill.

When windrowed as a precaution, later to be taken from the windrow and sent to the sugar mill, Co. 281, under normal conditions, shows the least amount of deterioration of the commercial varieties cultivated in Louisiana. The windrowing quality of the cane is well known to the planters, and the variety is used by them as a safeguard against heavy losses when winter conditions are severe. Windrowing tests conducted before and after the December freezes in 1934 confirm previous observations, indicating that when Co. 281 was windrowed before the temperature went to 22 degrees F., the variety kept satisfactorily; but that when the cane was windrowed after severe freezes of below 22 degrees F. had affected it, it was damaged to such an extent that keeping qualities in the windrow were materially lessened.

When harvested before a freeze, the variety C. P. 28-19 has been found to behave in somewhat the same manner as Co. 281. A limited amount of data indicates that it does not keep quite as well as Co. 281.

The variety C. P. 28-11 has shown a very great cold resistance under the conditions of 1934.

The recommendations of the Louisiana Sugar Experiment Station regarding the necessity of delivering freshly cut cane to the mills are now generally accepted throughout the state, and have been responsible for savings beyond measure to the cane grower. In Table 3 an illustration is given of the losses that may occur if cane is not milled soon after cutting.

TABLE 3

Deterioration Test

Variety	Cut and Analyzed Nov. 15 '34	Analyzed Nov. 21, '34
Co. 281	12.58	11.79
C. P. 28-19	14.94	13.05
Co. 290	13.46	11.28
C. P. 28-11	14.08	9.71
C. P. 29-320	14.61	10.95
P. O. J. 36-M	12.78	9.74

Approximate loss in dollars per ton of mill cane in a six-day period:

Co. 281, $.146 C. P. 28-19, $.483 Co. 290, $.368 C. P. 28-11, $.845
C. P. 29-320, $.683 P. O. J. 36-M, $.515

Here it is clearly demonstrated that in six days a cane grower can have a profitable year turned into a disastrous one through neglect on his part to deliver freshly cut sugarcane to the manufacturer.

DATE OF PLANTING

Varieties respond differently to plantings made in late summer. While it is not practical to plant cane as early as August 15 without a complete change in our rotation system, it is possible this early to plant such varieties as Co. 281, Co. 290, and C. P. 807. At Baton Rouge the best results from a field standpoint have been obtained from plantings of these varieties made from September 1 to September 15. The P. O. J. varieties do not respond to early plantings and should not be planted before October 1.

We have found that there is a period, varying somewhat from season to season, in which germination of sugarcane is not as satisfactory as when the cane is planted either before or after this period. The period at Baton Rouge hinges around November 1.

This earlier date of planting is highly advantageous from a practical standpoint in that it enables the cane grower to distribute his heavy field work over a longer period. With the contemplated commercial cultivation of C. P. 29-320 and the anticipated earlier starting of the mills through the use of this cane, which would tend to concentrate fall work greatly, the knowledge that we can plant certain varieties from two to five weeks earlier than has been customary becomes invaluable.

ROTATION

Under the conditions of our field work, when the soil has been put in a state of high productivity, no more profitable returns were secured from cane when two crops of summer legumes had been grown and turned under than when one crop of summer legumes had been turned under. A crop of *Melilotus indica* grown on the plant cane, as reflected in the stubble crop, was equal to one-half ration of nitrogen applied to both plant and stubble cane. The possibility of deriving a profit from nitrogen applied to stubble cane following *Melilotus indica* on plant cane is doubtful. In contrast, when no *Melilotus indica* was grown on the plant cane, the stubble responded to nitrogenous fertilizer.

The use of commercial nitrogen has not been profitable on plant cane, and hardly profitable on first year stubble when the best rotation practice has been followed. Nitrogen has been definitely profitable on second year stubble, and in this respect we find that when *Melilotus indica* has been grown on the plant cane, its value is clearly shown in a decreased demand for nitrogen on the stubble cane.

Yields of plant cane have been as good following cowpeas turned under as those following soybeans turned under; however, yields from stubble cane have been better following soybeans turned under.

On Louisiana plantations where soils have been built up through the proper treatment, similar crop returns should be secured. On the average Louisiana sugar plantation, where production is low owing to a poor soil condition, more fertilizer will be required to secure the most profitable returns. These two widely varying conditions should not be confused, for, while more fertilizer can be used advantageously on the lesser yielding soils, the amount of fertilizer which can be used profitably is limited; or, in other words, maximum profitable sugarcane yields cannot be secured through the application of commercial fertilizers alone.

FLAT CULTIVATION

Work along the lines of flat cultivation at Baton Rouge has shown that it is not necessary to have the high ridges that were once thought to be so essential to successful cane growing in Louisiana. The results of our experiments strengthen the findings of earlier work which forms the basis for our recommendations of deep soil preparation, a moderate ridge, and shallow cultivation. (We are not recommending the growing of cane on the flat.—See Louisiana Extension Circular 151 for full details of our recommendations on cane culture.)

RAPID PROPAGATION

The P. O. J. canes were used to rectify a disease situation which all but wiped out the Louisiana sugar industry. A second crisis was averted by the introduction of canes better suited to Louisiana. In the case of the P. O. J. canes, a great deal of money was lost before a seed supply could be built up. This same thing might have occurred in 1934 and 1935, if this station had not developed a method for the very rapid increase of new and desirable varieties.

We have developed and given to the cane growers the Single Eye Method of summer planting. This is a practical method by which as many as 1,300 stools of cane have been produced from an initial single stool within one year. By this method we are able to place a variety under general commercial cultivation five or six years earlier than by ordinary methods of planting.

RAPID FIELD TESTING FOR MATURITY

Heretofore a great deal of money has been lost, because there was no rapid method for determining the maturity of cane in different sections of the field or for determining the economic point for topping. Planters had to rely largely on their returns from the sugar house, and by the time these were secured, fields of cane that were either immature or had been improperly topped had been cut.

Through the use of the Zeiss Hand Refractometer we were able to develop a simple, practical, and rapid method for determining the maturity of cane in the field, and also for ascertaining the proper point at which cane should be topped in order to secure the most economic returns. We feel that this work is doubly valuable to the cane industry of the state for two reasons. First, it enables the growers to keep personally informed as to the wide variation in maturity, even within a small area, thereby eliminating controversies between growers and manufacturers. Second, it gives the cane growers a simple, rapid, and practical method for determining what fields of cane are mature enough to harvest.

CORN

Experiments conducted at Baton Rouge have clearly shown that the yields of corn, following stubble crops of the varieties of sugarcane now grown commercially in Louisiana, have been considerably less than were secured when the "Noble" canes were in general use. This, no doubt, is due to the fact that the stubble pieces from the newer sugarcanes decompose so much more slowly than did the stubble pieces from the "Noble" canes.

Experimental data have proved that a limited amount of nitrogen can be used to offset this lower yield of corn following stubble crops of the newer sugarcane varieties. An application of 15 pounds of nitrogen per acre to corn following such stubble cane has given profitable returns under average growing conditions. Except under ideal conditions, a heavier dose of nitrogen has not proved profitable.

In the case of corn plantings following stubble cane of the newer varieties, a quick-acting fertilizer is needed. A slow-acting nitrogenous material may not become available until after the corn crop has been severely stunted.

The following table illustrates the preceding statements. From the data presented, it can be readily seen that an application of 100 pounds of nitrate of soda was highly profitable; 200 pounds gave an increase over 100 pounds, but the increase was not large enough to pay for the extra 100 pounds of fertilizer. In a contrast between the corn following sugarcane and corn following a crop of soybeans turned under, even an application of 100 pounds of nitrate of soda to the corn following the legume turned under was not profitable.

FERTILIZATION OF CORN FOLLOWING STUBBLE CANE OF THE NEWER "HYBRID" VARIETIES

Check	100 lbs. Nitrate of Soda	200 lbs. Nitrate of Soda
27.79	39.41	41.83

FERTILIZATION OF CORN FOLLOWING CORN AND SOYBEANS, THE SOYBEANS BEING TURNED UNDER TO IMPROVE THE SOIL FERTILITY

Check	100 lbs. Nitrate of Soda	200 lbs. Nitrate of Soda
48.34	49.84	51.46

There are cases in which nitrogenous fertilizer can be used on plant cane and on corn following a crop of legumes turned under. When a planter finds such a practice to be profitable on his lands, he should take advantage of the fact. The planter should realize that he has not done his part by his land and should immediately plan his cropping system so that the land will be systematically built up to a stage of maximum profitable productivity.

PART II

Testing Canes for Disease Resistance in Louisiana*

By

C. W. EDGERTON, Plant Pathologist, and

E. C. TIMS, Associate Pathologist.

On account of climatic conditions, it is not possible to carry on breeding work with sugarcane in Louisiana. Being outside the tropics, sugarcane does not normally produce flowers, and viable seed have as yet never been produced. This means that the planters of Louisiana must depend on other regions for new cane varieties. Most of the new canes that are now being brought into the state come from the breeding station of the United States Department of Agriculture at Canal Point, Florida.

Practically no information is available on the new seedlings when they are brought to the State Experiment Station at Baton Rouge. The parentage of the canes is known, but other information is very meager. Practically nothing is known in regard to their adaptability to Louisiana conditions or their resistance to the diseases which are of economic importance.

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* This article has also been sent to the meeting of the International Society of Sugarcane Technologists which is to be held in Brisbane, Australia, in August, 1935.

Practically complete and accurate information about these new seedlings must be obtained in a comparatively short period of time. By the end of the second year after they are received, the agronomist has sufficient information in regard to the sucrose content and yielding characteristics to know whether they have any promise. The few that do show promise are placed in increase plots, and the next year those that are left are ready to go to the test fields throughout the state for further tests and for rapid increase. By the end of the first year in the test fields, the plant pathologist must be able to state fairly definitely how resistant or susceptible each of these is to the diseases of major importance. In a former generation, the canes that were received by the Experiment Station from various locations in the tropics were cultivated on a small scale from year to year. This was believed to be necessary in order to determine how these canes would react during favorable and unfavorable years. At best this method was slow and the results obtained were not very reliable unless the canes were grown for a numbr of years, and in years both favorable and unfavorable for cane growth. At the present time, information which is more reliable can be obtained in the two years in which the canes are being grown in the increase plots before they are ready to be released for general planting.

The diseases which are considered of the greatest economic importance in Louisiana are as follows: (1) the stubble deterioration complex of factors, (2) red rot, and (3) the mosaic disease. The comparative resistance of each seedling to each one of these must be definitely known before a variety can be released for general planting.

Stubble deterioration is very important in Louisiana. It includes all of those factors which kill out or lower the vitality of the cane stubbles from the time the cane is harvested in the fall until normal growth can take place in the spring, usually a period of about four months. Included among these factors are the susceptibility to cold and excessive soil moisture, the susceptibility to the root rot complex of factors, and to such stalk-rotting organisms as the red rot fungus and a few others that are known to attack the stubble pieces before the young shoots become established in the spring. A variety which is not very resistant to stubble deterioration is worthless in Louisiana. This was one of the most important weaknesses of the old D. 74, a variety which was grown in Louisiana for many years.

As the deterioration which may occur in the winter is very closely associated with weather conditions, it is not easy to determine the stubbling characteristics of a cane by field tests. Following a favorable winter almost any variety may make a very satisfactory stubble or ratoon crop. Following an unfavorable winter, however, recovery of the stubble may be poor and unsatisfactory. This means that a cane may be grown in the field for a number of years and appear apparently satisfactory, and then, rather suddenly, when some unfavorable condition occurs, it may fail. Varieties which respond in this way are dangerous canes. If planted on a large scale, it is just a matter of time until crop failures result.

A method* has been worked out in Louisiana which enables us to determine the stubble deterioration characteristics of a cane in favorable as well as in unfavorable years. Some of the canes now in cultivation, such as P. O. J. 234 and P. O. J. 213, are known to be very susceptible to stubble deterioration, while others, such as Co. 290 and Co. 281, are known to be very resistant. In testing new canes, it is possible to compare them, then, with both resistant and susceptible canes, and the comparative

*Edgerton, C. W., Tims, E. C., and Mills, P. J., Stubble deterioration of sugarcane. Louisiana State Agricultural Experiment Station Bulletin 256. 1934.

resistance can be very readily obtained. To determine this resistance, stubble pieces, usually about 100, are dug at specified times during the winter, generally in December, late February, and the latter part of March or the first of April. The number of good and dead eyes on the stubble pieces, the number of pieces showing some discoloration, and the number apparently dead are determined. The stubble pieces are then split open and one-half of each is placed in a moist chamber for not more than four or five days. By that time those affected with red rot will have spores on the cut surfaces, and the red rot infection can be determined by microscopic examination. If these pieces are left in the moist chamber more than four or five days, spores may be present which come from secondary infections following the splitting of the stalks. It has been found from tests carried through several years that poor stubbling canes will show a lower percentage of good eyes and a higher percentage of dead stalks even in very favorable years than will good stubbling canes. When the results for the three examinations are available, a direct comparison may be made with the cane of known stubbling characteristics. If the results obtained with a new seedling are similar to those obtained with either P. O. J. 234 or P. O. J. 213, the cane is considered susceptible to stubble deterioration, but if it compares well with Co. 281 or Co. 290, it may be considered a safe cane. In two years results can be obtained which are more reliable than results obtained over several years in general field tests.

Some information on the resistance of cane seedlings to the red rot disease is obtained from the stubble deterioration tests, but this is not usually sufficient, as the disease affects the standing cane as well as the stubble pieces and the planted cane. Information on the resistance of a cane plant to the progress of the fungus must also be available. The fungus may spread very rapidly in a stalk when infection occurs and yet not easily gain entrance to a standing stalk in the field. Such a cane is resistant to infection. The rate of growth of the fungus in a cut stalk may also vary considerably from that in a standing stalk. To come to any conclusion, then, in regard to susceptibility to red rot, stalks must be inoculated both in the field and in the laboratory. Pronounced susceptibility to red rot as determined by either method is undesirable, and canes showing such susceptibility can have but little value for future plantings. Susceptibility to red rot has been a very important factor in discarding the variety, P. O. J. 213, and has definitely eliminated certain promising seedlings.

The problems concerned with the mosaic disease are more complex than those concerning some of the other troubles, and it is not as easy to speak with certainty in regard to the susceptibility of a variety to the disease. Information obtained during a period of several years suggests that strains, possibly comparable to the physiologic strains of fungi, probably occur with the mosaic diseases of sugarcane. From a symptom standpoint, there are two very definite types of mosaic. These are being called the green type and the yellow type. In the latter, chlorophyll is very deficient in the light-colored areas. Much information has been obtained during the past few years in regard to the susceptibility of different varieties to the two types, the period of incubation of the virus in the plants, and the amount of infection procured following juice inoculations. It is also believed that distinct strains of the virus occur which usually produce similar symptoms, but which attack certain varieties more readily than others. This means that a variety may remain immune or very resistant for a number of years and then suddenly become very susceptible. This occurred in Louisiana with the varieties, P. O. J. 213 and Co. 281.

The knowledge of the ability of a variety to throw off the disease, or to recover, is also important. The percentage of recovery of some varieties from the mosaic disease is very high. Of the new varieties which show considerable promise at the present time, C. P. 29-320 shows this peculiarity to a marked degree.

Mosaic normally spreads very rapidly in Louisiana and the relative susceptibility of varieties can usually be procured rather easily by obtaining the percentage of infection and the rate of increase of the disease in the test plots during the two years that the seedlings are being increased. On susceptible varieties the spread of the disease is very rapid. In recent years no new seedlings showing marked susceptibility to mosaic has been considered a commercial cane. Besides the field determination of susceptibility, the recovery from mosaic is obtained by tagging and watching infected plants. Furthermore, inoculations are made in the field with different mosaic types. The percentage of infection obtained from inoculation and the period of incubation are important factors in determining mosaic resistance. A variety in which the period of incubation is long is ordinarily more resistant than one in which this period is short.

It is believed that the system employed at the present time in Louisiana eliminates to a very large extent the selection of seedlings which later might become dangerous. It has already eliminated a number which in many ways seemed to have considerable promise. If carried on consistently in the future, the planters need not worry about severe disease epidemics and crises similar to those which have occurred from time to time in the sugar industry in the past.

Disease Resistance of Commercial Canes

By

E. C. Tims, P. J. Mills, and C. W. Edgerton

Since the crop failures in the period between 1924 and 1927, many hundreds of cane varieties and seedlings have been brought into Louisiana for trial. Out of this large number only a very few have shown sufficient promise to be released for general planting. Before a cane can be released, it must meet certain standards. It must show a satisfactory sucrose content, it must be adapted to Louisiana soils and climate and yield satisfactorily under most conditions, and it must show a satisfactory resistance to the diseases that are of major importance. To be released, a cane must equal or be superior to others which are being grown commercially. None of the canes which have been released in recent years is perfect nor do any approach very close to perfection. It should not be assumed that any of these will become permanently established. A cane has its value even if it raises the sugar production in the state for only a very limited number of years. It is assumed that better canes will be produced, and the sugar planters should not hesitate to discard canes, even though they have benefited them very materially, for others which will do better.

During the period since 1924 certain canes have become established as commercial canes. Some of these are already passing out of the picture and others will follow. The canes which have been released during this period are as follows: P. O. J. 234, P. O. J. 213, P. O. J. 36, P. O. J. 36M, Co. 281, Co. 290, C. P. 807, C. P. 28-11, C. P. 28-19, and C. P. 29-320.

As susceptibility to disease is one of the most important factors when selecting canes for planting purposes, it is important to know how well the present released varieties meet the present standards in regard to resistance to disease. The diseases or disease complexes which are most important and which should be considered include susceptibility to stubble deterioration factors, red rot, and mosaic. Any cane which shows a low resistance to any of these is not a satisfactory variety.

Stubble Deterioration: The resistance of the released canes to stubble deterioration factors has been brought out in a recent bulletin* and it is only necessary to give the general results at this time. The comparative resistance of these varieties is about as follows: *Very susceptible*: P. O. J. 213, P. O. J. 234; *Resistant to highly resistant:* P. O. J. 36, P. O. J. 36M, Co. 281, Co. 290, C. P. 807, C. P. 28-11, C. P. 28-19, C. P. 29-320.

The susceptibility of P O. J. 213 and P. O. J. 234 to stubble deterioration factors is so pronounced that they are being classed as dangerous canes and should not be planted except in localities where stubble deterioration is not important.

Mosaic: Some information on the resistance of the released varieties to mosaic has been brought out in a recent bulletin,† and again it is only necessary to give the general results which have been obtained. The comparative resistance of these varieties at the present time based on the reduction in yield is about as follows: *Very susceptible*: P. O. J. 213; *Moderately susceptible*: P. O. J. 36, P. O. J. 36M, Co. 281; *Moderately resistant*: P. O. J. 234, Co. 290, C. P. 29-320; *Resistant*: C. P. 807, C. P. 28-11, C. P. 28-19.

The susceptibility of P. O. J. 213 is sufficiently pronounced to make it unsatisfactory for planting purposes.

The canes in the moderately susceptible group, P. O. J. 36, P. O. J. 36M, and Co. 281, are injured to a considerable extent by mosaic. Of these, Co. 281 is at present the most valuable cane. This cane is so important that it cannot be discarded at the present time. There is no variety to take its place. However, as time goes on, varieties may be developed which will gradually eliminate Co. 281. The resistant and moderately resistant varieties are not at present being injured seriously by mosaic. There is always a possibility, however, that resistant varieties may become more susceptible as they are grown for longer periods and such varieties must be carefully watched.

Red Rot: It is not possible to group cane varieties as satisfactorily in regard to their resistance to red rot as it is with the other diseases. This is due to the fact that the disease is caused by a living organism which is very variable. In nature strains of the organism exist which show a great difference in virulence and there is no reason why new strains should not develop from time to time. This means that a variety which was resistant at one time might be quite severely attacked at another time or under different conditions. However, enough evidence is available to give some idea of the comparative resistance of the released cane varieties and these varieties may be grouped on this information. *Very susceptible*: P. O. J. 213. *Very susceptible to moderately susceptible:* P. O. J. 36, P. O. J. 36M, C. P. 807; *Moderately susceptible to moderately resistant:* Co. 290, C. P. 29-320; *Resistant:* P. O. J. 234, Co. 281, C. P. 28-11, C. P. 28-19.

Severe losses from red rot with a very susceptible cane like P. O. J. 213 can be expected. Losses with canes in the very susceptible to moderately susceptible group may occasionally occur. Canes in the other groups are less apt to be materially injured by the red rot. However, even a cane that is moderately susceptible may suffer under some conditions.

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* Edgerton, C. W., Tims, E. C., and Mills, P. J., Stubble deterioration of sugarcane. La. Ag. Expt. Sta. Bulletin 256. 1934.

† Tims, E. C., Mills, P. J., and Edgerton, C. W., Studies on sugarcane mosaic in Louisiana. La. Ag. Expt. Sta. Bulletin 263. 1935.

When all the diseases are considered, it is seen that the newer varieties, C. P. 28-11, C. P. 28-19, C. P. 29-320, and Co. 290, more nearly meet the standards for disease resistance than do the other varieties.

PART III

Recommendations for Control of the Sugarcane Borer In Louisiana

By

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Introduction

During the past ten years especially, the entomologists of the Louisiana Experiment Station have been studying intensively the problem of controlling the sugarcane moth borer* in this state. This borer is particularly destructive to sugarcane and corn but less injurious to rice in Louisiana. Occasionally the borer has caused complete destruction of crops of cane and of corn over considerable acreage. During recent years the damage has decreased considerably below the average of approximately 20 per cent loss which was estimated to occur from about 1915 to 1925.

Out of the mass of observations and experimental results have come a number of rather definite conclusions regarding control measures which have been found generally effective and practicable in plantation practice. These conclusions will be stated as briefly as possible in the form of definite recommendations without an attempt to include therewith many details regarding the grounds on which they are based or the specific conditions under which they may apply. For such details, we must refer to various bulletins of the Louisiana Experiment Station and to numerous articles in the Journal of Economic Entomology and in The Sugar Bulletin. The recommendations are arranged in the order in which they should be applied through the season.

Recommendations

1. *Cut out "dead-hearts" caused by first generation borers* when they appear abundantly in cane. Dead-hearts are caused principally by borer larvae and indicate that first generation larvae are becoming full-grown. The time for cutting out occurs usually during the last week of May or the first week of June. In every case the best time should be determined accurately by cutting out sample lots of at least 25 dead-hearts every four or five days after May 20 and recording for each sample in tabular form the date, field, variety of cane, numbers of stalks cut, and the numbers

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* *Diatraea saccharalis* (Fabricius)

of large borer larvae, of pupae, and of empty pupal skins found. The most effective and economical time for a single cutting is just when some pupae have become nearly black in color or when the first empty pupal skins occur. Repeated rogueing may be advisable at 7 to 10 day intervals. Not all dead-hearts appear at one time, though the problem is to secure as large a proportion as possible of dead-hearts without allowing the escape of moths, or to repeat the rogueing as numerous additional dead-hearts develop. Only extra-dependable laborers should be used and they should be trained to cut the dead-heart stalks low enough to be sure of getting the borer stages therein. Knives with stout blades from 6 to 8 inches long are needed for this work. As each dead-heart is removed, it is best to slit it immediately and destroy the borer stage therein. This practice assures the immediate destruction of the borer and also shows the workman whether he is cutting low enough to get all borer stages. It will always be true that many borer burrows will be found empty. This may be due to the fact that one larva may cause more than one dead-heart, or possibly the larva or pupa may have been removed by predaceous enemies. If dead-heart stalks are removed from the field, there is always some question about the thoroughness of their destruction or the possibility of moths emerging therefrom before destruction is accomplished. Areas requiring rogueing of dead-hearts should also receive parasite colonization (No. 3) in about two weeks after the rogueing began. No attempt should be made to remove dead-hearts later in the season than for first generation borers. As the cane becomes larger, a very much smaller proportion of borer-infested stalks show dead-heart type of injury and the expense for rogueing is greatly increased also.

2. *Destroy heavily infested early corn* in gardens or fields before first generation moths can emerge therefrom. It happens very frequently that early borer infestation is concentrated in a marked degree upon early developing corn. A maximum of good in reducing the emergence of first generation moths can be accomplished, therefore, by destruction of such corn at the proper time. The extent of this infestation is found very easily just at the time the first corn tassels appear. Very fine leaf perforations across unfolded leaves are due to feeding of young borer larvae within the leaf-roll. Burrows or excrement masses showing in the leaf axils in the lower part of the stalks are also sure evidences of cane borer infestation. If more than one-fifth of all stalks show these signs, it is considered advisable to cut out all of the corn and feed it to farm animals. Be careful to cut at or below the ground surface and also, particularly, to remove all stunted stalks. It is advisable to run all of the corn through feed choppers such as are available on most sugar plantations in Louisiana. If the corn is fed, without being chopped, the harder butt portions will likely be left uneaten. These may be destroyed by feeding to hogs or by running through ensilage cutters or cane grinders. Deep burial, burning or complete submergence under water will also effectively prevent the emergence of moths from such infested material.

Recommendations 1 and 2 may accomplish a very substantial reduction in the number of first generation moths maturing. The expense therefor is small and the benefits should continue throughout the season.

3. *Colonize egg parasites (Trichogramma minutum Riley)* upon the borer eggs as they are being laid for the second generation. Colonized areas should include all areas of corn or cane where evidence of first generation development occurrd in any considerable abundance. As a general rule, this will include the earliest planted areas of corn and the most advanced thrifty-growing fields of cane. Among the varieties now being produced commercially in Louisiana, first stubble fields of such varieties as C. P. 807, Co. 281, and Co. 290 should be considered favorable areas for parasite

colonization, as a general rule. The time for colonization usually occurs between June 5th and 25th for second generation eggs. The release of 5,000 to 6,000 parasites per acre is considered sufficient for June colonizations. Corn is likely to call for slightly earlier colonization on account of the somewhat more rapid development of borers which occurs commonly in corn. The third generation of borers in Louisiana may begin in corn fields as early as the 1st of July, but does not usually begin in cane until after the 20th of July. The easiest method of determining exactly when parasites should be released is to follow the development of the borer stages at the maturity of the first generation in corn and by examining dead-hearts in cane. As soon as empty pupal skins can be found in fairly frequent numbers, it is time to release parasites in that area. A similar method for determining the time for later releases may be followed if care is taken to distinguish between the empty skins remaining from first generation emergence and those produced by the emergence of second generation moths. This can usually be determind quite positively from the condition of the burrows and the age of the stalks in which the borers occur.

Later colonization may be made in either corn or cane as borer infestation conditions indicate to be advisable. This work may be continued, particularly in plant cane areas, to the 10th of September. After the middle of July, it is considered advisable to increase the number of parasites released to about 10,000 per acre.

The proportion of borer egg hatches turning black shows how effective the parasites are at any period during the season. After parasites are released under proper conditions, the planter may rest assured that they will return him a handsome profit on the small cost involved for colonization. Parasite colonization must be repeated each year because this egg parasite is absolutely dependent upon finding the eggs of some possible host species in which they may continue development slowly for two, three or more generations during the winter season. At this time no cane borer eggs exist in the field. The egg parasite does not hibernate as an adult, but continues its activity during periods of warm weather, and the development may be extended to six weeks or more for a generation of parasites in the winter in Louisiana fields. Therefore, from about November 15th to the last of March each year it is practically impossible to find any Trichogramma in cane fields. This break in their host egg supply eliminates Trichogramma from cane fields each year and reduces the number of parasites surviving the winter to a very small number which may find the eggs of some moth or butterfly species around winter gardens or evergreen shrubbery, etc. Fom such locations the parasites must multiply in the spring and again spread into the large areas of corn and cane.

In the course of parasite colonization experiments during the three seasons of 1932 to 1934, inclusive, we have been able to secure reports from plantation owners and mill operators covering 39 colonized fields and 31 check fields, comparable with the colonized areas. The average net profit from parasite colonization, as shown in these 70 test fields has amounted to over $18.00 per acre. This is based upon an average increase in all colonized fields of 528 pounds of sugar per acre, and the average value to Louisiana planters during this period of 3.8 cents per pound for sugar. The cost for parasite colonization is approximately $1.00 per acre at the rate of 5,000 to 6,000 parasites per acre.

4. *Dust cane* (not corn) *with high-grade light sodium fluosilicate* early in July where parasite colonization was not done, or where this was done too late to check the hatching of second generation eggs. The abundance of hatching of eggs is again shown by the presence of fine leaf perforations in the top leaves of the stalks late in June or early in July. If these perforations are very numerous, it indicates that a

large number of eggs have hatched. Thereafter control by parasites is not possible in that generation. It is possible, however, to reduce the number of borer stages developing by dusting the cane with sodium fluosilicate applied by saddle guns, from mule back, and using 12 to 15 pounds per acre. Apply this dust in the late evening when the air is quite still and the leaves are fairly dry. Such dusting, properly applied, and followed by dews and light rains, should destroy more than half of the borer larvae in the cane during the next two weeks. This dusting does not destroy the egg parasites occurring in the field, and the practice of dusting may well follow parasite colonization and will add to the efficiency of the parasite. The planter should not be alarmed if the more nearly matured leaves at the base of the cane stalks turn yellow soon after the dust is applied. Such leaves are in process of maturing. The sheath has loosened from the stalk and it appears that these leaves are no longer of functional value in the growth of the plant. They will soon die of their own accord. The growth of the stalk is not checked if these basal leaves are stripped away entirely. One dust application at this special period for checking the second generation of borers, and where parasites are not generally abundant, is all that we recommend.

5. *Plant borer-free seed cane* whenever possible to secure it. A minimum of borer infestation in the seed cane reduces the amount of seed required to assure a full stand in the following crop. This reduces the number of gaps or skips in the plant cane and in subsequent stubble crops also. Furthermore, it reduces the initial borer infestation in the plant cane crop. Experimental work has shown that borer-free seed cane increases the yield in subsequent crops by from 10 to 20 per cent above yields secured from using even lightly-infested seed.

6. *In harvesting cane,* it is important that the cutting should occur at or below the ground level. Low cutting eliminates practically all borer stages from the stubble and thus reduces the number of borers entering hibernation or surviving in the stubble where they are not likely to be destroyed during the winter by climatic conditions or by any artificial methods of disposal of cane trash.

7. *General clean-up* should be practiced in all cane plantation areas to destroy scattered stalks around hoists, along railway lines, and roadways and at factory yards.

Cane borers have been found to survive the winter in considerable numbers in old dried corn stalks. Such survival may be prevented by the practice of burning the stalks when they are fairly dry. Survival is decreased by merely breaking down the corn stalks early in the fall so that they rot out more thoroughly by being in close contact with the moisture on the ground.

The cane borer also hibernates extensively in areas of Johnson grass and other larger stemmed grasses which may occur along ditchbanks, headlands, and adjacent to cane and corn areas. Attention should be given to fall or winter clean-up of such areas in such a manner as to destroy the borer stages hibernating therein. Infestation in rice stubble may be eliminated by flooding the fields during the winter season.* Attention to these points may be necessary in areas where sugarcane is not grown.

8. *Burn cane top trash as thoroughly as possible* so as to destroy all borer larvae passing the winter therein. In all cane areas where borers are known to have been abundant at harvest time, it is advisable to have workmen throw the trash to the tops of the ridges soon after harvesting. Leaving such trash on the row during the early part of the winter protects the stubble from heat during December and reduces the sprouting at that season. Heavy sprouting during December is generally considered very unfavorable for the stands of cane in the following spring. Allow

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*Recommended by U. S. Bureau of Entomology workers.

the trash to remain on the ridges until the latter part of January. By this time minimum winter temperatures will probably have occurred and the stubble will have been protected not only from heat but also from excessive cold. Then with only a few warm days the trash will be sufficiently dry to allow a very thorough burning and complete destruction of borer stages therein. The burning of top trash has no effect whatever upon the survival of the cane borer egg parasite. It is the most effective method yet found for destroying a large proportion of the borer stages in hibernation.

Borer survival has been found by extensive experimental work to be decreased by at least 75 per cent in areas receiving what we would call an average plantation burn, and may be reduced much beyond that point by the thorough type of burning suggested above.

By utilizing as many as possible of the foregoing recommendations, sugarcane growers in Louisiana may be assured that borer damage will be greatly decreased.

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The Population of a Selected "Cut-Over" Area in Louisiana

By

T. LYNN SMITH AND MARTHA RAY FRY

COOPERATIVE PLAN OF RURAL RESEARCH
Federal Emergency Relief Administration
Federal Emergency Relief Administration of Louisiana
Louisiana Agricultural Experiment Stations

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The Population of a Selected "Cut-Over" Area in Louisiana

By T. Lynn Smith and Martha Ray Fry

I.

INTRODUCTION

Our era is characterized by wholesale proposals and programs designed to bring about a more equitable adjustment between the population and the land. In the United States the attention of the citizenry is concentrated upon the New Deal's phrases, proposals, and programs, among which those relating to adjustments between the population and the land always stand out prominently. But such efforts are not confined to this country; parallel developments are occurring in other lands. We might mention that land for the masses is the fundamental problem with which Mexico is struggling. The "green rising" has not yet spent itself in Europe. Russian peasants early lent their support to the program which promised them lands, and struggles over land still convulse the nation. Italy has initiated far-reaching schemes for resettlement and colonization. Similar projects are under way in Germany. Land problems likewise play a very important part in Japan and many other countries.

It may be observed, however, that the problem in the United States differs from that in other countries. We are constantly warned of our "unneeded" and "surplus" agricultural lands. Our trouble has been diagnosed as arising from a superabundance rather than a scarcity of lands, as is the case in other countries. In addition to "benefit payments" to individuals for reduction in acreage of "basic crops," one aspect of the program underway in this country has taken the form of designating large areas of territory as marginal or submarginal for agricultural purposes and initiating programs to divert these lands to other than general farming uses. Another departure has been to block off and designate large territories as "forest-purchase areas." Machinery also has been put in order for buying up and transforming still other acreages into recreational areas, parks, and playgrounds.[1]

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[1] Providing our national ailments have been properly diagnosed, one cannot be too loud in praise of any honest attempt at outlining an intelligent land policy while the problem is still one of overabundance. However, before giving wholehearted endorsement, one must be satisfied with the diagnosis. It seems that the calm analyst should inquire concerning the weight given to some factors whose importance is nowise diminished by the abruptness with which they are customarily thrust aside. One asks, what of the frenzied rush of population to urban centers which characterized the post-war period? What of the acute relief situation now prevailing in these same urban areas? And one wonders if these aren't somehow related. Are they evidences of an unnatural skewness towards urbanism in our contemporary society? And would our surplus lands be so great if this skewness were corrected? Again, one may reflect upon the recent trends in the productive and consumptive practices of our rural population. Today agricultural leaders and institutions throughout the nation are emphasizing the importance of "live-at-home" programs. This is in sharp contrast to the recent emphasis upon commercial farming. It is entirely out of accord with the rapid decrease in self-sufficiency which has occurred on the American farm. It seems to cry out how shortsighted much of our agricultural philosophy has been. Even though a rising standard of living has

In view of the fact that such large-scale transfers of population are being proposed, it behooves fact-finding agencies to concentrate their efforts upon securing the data needed for the successful guidance of such programs. This report is designed to furnish the basic facts pertaining to the present situation and prospects of the population in what has been called a "trouble," "submarginal," or "land-retirement" area in the State of Louisiana. It was inspired, partially, by the programs of action now being pushed by the Federal Government along the lines of rural rehabilitation, rural resettlement, and subsistence homesteads. However, interest in it was first aroused by the realization that many parts of Louisiana and the nation are a severe liability and drawback to other portions. If the programs mentioned above are to have the slightest chance for success in remedying the situation, they must be based upon accurate information pertaining to the problem that is being dealt with. It should be unnecessary to stress the fact that the population aspects are the most fundamental phases of the situation: land utilization is meaningless unless viewed as an adjustment between the population and the land, and of the two factors, land is by far the more fixed element.

The present study was conceived and executed under the Cooperative Plan of Research entered into between the Rural Research Unit of the Federal Emergency Relief Administration, the Louisiana Agricultural Experiment Station, and the Louisiana Federal Emergency Relief Administration.[1] The broad objectives of the investigation were to secure an adequate picture of the situation and prospects of the population in a selected "trouble area" of the State. The particular area chosen for study is located in the rolling pine-covered hills which lie between the Red and Mississippi Rivers. Generally speaking, the top soil is shallow and the land unproductive, although patches of excellent soil are to be found bordering some of the small streams in the area. The region is one in which the lands have been judged too poor for agricultural purposes and have been recommended for retirement;[2] it is also an area in which lumbering has been one of the chief bases of support for the population; the region is characterized by excessive tax delinquency, followed by the adjudication of lands to the State; finally, it is a territory in which the size of the relief load and the difficulty of carrying on ameliorative projects have sorely taxed the ingenuity and energies of the people in charge of these undertakings.

The original plans called for studies of three areas: one in which the lumber industry offers promise of continuing for some years to come, a second in which the lumbering industry is now in the process of "cutting out" or discontinuing its

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resulted from our commercialized farming (which itself is debatable), may not the cost of this, in terms of stability and security, have been too great? These questions cannot, of course, be answered decisively but one can hardly help thinking that they are essential to any adequate inventory of our actual needs for land.

[1] Mr. J. H. Crutcher, Assistant Administrator, and Miss Maude Barrett, Director of Social Service of the Louisiana Emergency Relief Administration, were particularly helpful in making possible the present study.

[2] See the Report of the National Resources Board, 1934, p. 176, which presents a map showing the location of land-retirement areas in the United States and says of them: "Within these areas are farms from which arable farming should ultimately be encouraged to withdraw, mainly because experience has demonstrated the land to be too poor to provide adequate family living and support public institutions and services. Agricultural occupation of many of them continues only by grace of continual public subsidy or relief."

operations due to exhaustion of timber resources, and a third in which the timber resources have been exhausted and all the sawmills shut down for several years. It was thought that such studies might present a picture of successive changes in the social and economic situation just as they are being precipitated by changes in the basic industry, lumbering being the industry in this case. It was likewise thought that changes in similar areas would proceed in somewhat similar cycles so that it might be possible to foretell changes which are imminent in certain areas from the past experience in similar areas. If this is true, it should greatly assist agencies engaged in preventive and remedial measures. But there are other important uses for the results of such a study. When any program is attempted, without first having adequate facts pertaining to the situation which is being dealt with, it is almost certain, in progressing, to give birth to a series of charges and counter-charges. Violent disagreements are likely to arise pertaining to the original state of affairs; the need, or lack of need, for the remedial measures in the beginning; the progress, or lack of progress, as the program goes along; and the benefits, or lack of benefits, as the undertakings are carried to their conclusion. Needless to say these charges and counter-charges engender more heat than light upon the subject, while misunderstanding coupled with partisan politics can disrupt the best and most needed programs. Withal the cost of securing knowledge of the factual situation is but a drop in the bucket as compared to the cost of carrying on the remedial measures. For all these reasons, a careful inventory of the actual situation in some of the representative regions summarizing the basic facts pertaining to the situation being dealt with is a very worth while and valuable piece of work. It is difficult to understand how an able administrator would proceed without having such basic information.

The present study is concerned with the situation in the second of the areas mentioned above, i.e., in an area where the mills are just now cutting out. The region selected for study was Ward 3 in LaSalle Parish. It was chosen after conferences with the State Land Planning Consultant of the National Resources Board, the State Relief officials, and the local Agricultural and Relief officials. This area was chosen for special study because of the serious situation confronting its population. The timber resources are now about depleted. Two sawmills have already "cut out" and shut down. The remaining mills are operating at from 35 to 45 per cent of capacity and even at this have only a few years left to run. Many of the people who formerly obtained a livelihood from the lumber industry are left stranded in the rural sawmill villages. Others are "squatting" on company land. Still others are confronted with loss of employment in the very near future. Obviously the people in the area are facing an immediate readjustment, and agricultural pursuits are those most frequently mentioned as an alternative. But the entire Ward is included in the area recommended for retirement from agricultural purposes, making the prospects of gaining a livelihood from agriculture in the surrounding territory very slender. Besides agriculture, lumbering and one small gravel pit, there is at present no basis for the support of the people in the region. Trade within the area is negligible. The only villages in the Ward are Trout and Good Pine, and both of these are exclusively sawmill villages, or in other words, clusters of company houses in which the employees of the sawmills and their families reside. Most of the trading is done at Jena, the Parish seat, which is one mile from the eastern boundary of the Ward. This Ward is representative of large areas in the State of Louisiana.

The study was conducted by means of a house-to-house canvass in which every family in the area was visited. Enumerators were given careful training in the use of a schedule that had been worked out by members of the Rural Research Unit of the Federal Emergency Relief Administration in Washington and then carefully revised to fit Louisiana conditions. Each schedule was carefully edited, and whenever answers were lacking or questionable, a second visit was made to the family. A period of four months was spent in collecting the information secured in this survey.

We shall begin by showing the chief characteristics of the population in the area. This will be followed by a discussion of the group's mobility in the past and its reactions to proposals of removal. Next will be presented an analysis of the economic bases of living in the region. Finally some discussion of future prospects of the population in this territory will be given.

II.

COMPOSITION OF THE POPULATION

1. *Number and Density of the Population.*

As of January 1, 1935, our enumerators found a total of 862 families or households in the Ward selected for study. The individuals in these households numbered 3,385. Since there are approximately 104 square miles of territory in the Ward, the density of population averages 32 persons per square mile. Excluding the inhabitants of the villages and camps, there were about 12 persons per square mile. Our count showed 208 fewer persons than the number (3,593) given by the Census of 1930 and immediately brings up the question as to whether the decrease was actual or merely fictitious. In this survey we made strenuous efforts to reach every family in the area. There is small likelihood that the Census over-enumerated the population in 1930. Therefore, it seems probable that a decrease in population has actually occurred during the last five years. This probably reflects the natural readjustment in the population, which is taking place due to the curtailment of the lumbering industry in the Ward.

2. *Racial Composition.*

Three races are represented in the area: white, Negro, and Indian. Of the 862 households, 531 were white, including 2,330 members. In other words, white people comprise 69 per cent of the population and 62 per cent of the families. Furthermore, the entire white population of the Ward was native-born; in fact, not a single individual living in the Ward, white or colored, was born in a foreign country. Negroes numbered 1,020 and were distributed among 326 households. In terms of percentages they made up 30 per cent of the individuals in the population, but since the average family was smaller among them than among the whites, they constituted but 37 per cent of the families. In addition to the whites and Negroes there were five families of Indians (Choctaws) in the area. These five Indian families contained 35 members, which is one per cent of the population residing in the Ward.

A comparison of these data regarding racial composition with those reported by the Census of 1930 is interesting. The Census reported a total of 2,313 white people or only 17 less than our count showed. It reported 35 Indians, which is exactly the same as our enumeration. But the Census reported a total of 1,245 Negroes, which exceeds the number our enumerators found by 225. As we shall see, Negroes are concentrated in the villages, which makes it unlikely that they were missed in either enumeration. Thus it would appear that the white and Indian populations have held their own during the last five years, while the Negro population has decreased by about 18 per cent. The fact that Negroes in the area have been confined almost entirely to the sawmill villages, and that the mills have been closing out, makes it clear why this decrease in the Negro population should have occurred.[1]

3. *Residence.*

The population of the area was, of course, entirely rural. The same is true of the entire Parish, as evidenced by the fact that Jena, the Parish Seat and largest center, had only 1,007 inhabitants in 1930. Within the Ward, however, there are two important groups which we must consider separately. On the one hand we have the population whose sole or main dependence is the lumber industry. These people reside in the small sawmill villages and lumber camps and are quite distinct from the open-country population, who reside either in little clusters of small family-sized farms or as squatters in small woodland clearings. The open-country population is dependent primarily upon agriculture, although a great many other enterprises supplement the income.

It should be noted that in the open country the population was not evenly dispersed throughout the area. Farm families were found clustered together in little groups[2] along the relatively fertile beds of the small streams which flow through the region, leaving wide expanses of territory practically uninhabited. A great deal of this unutilized area is the property of large lumber companies which have no further use for the land now the timber has been removed. The families that we have designated as residents of woodland clearings are found pretty largely on these "company" lands. They are permitted to live on the land in return for a nominal charge of 50 cents or one dollar per year, a fee collected to insure the property owner that the settler would not obtain "squatter's rights" through his residence on the land.

Table I shows how the families and individuals in the area were distributed among the various residence categories. It will be observed that there is a very striking concentration of Negroes in the sawmill villages and logging camps and that they are practically lacking among the farm population. In the entire Ward only 11 Negro families were found occupying farms. However, there were three additional families of Negroes located as squatters in small clearings in the woods. There are two considerations which make this scarcity of agricultural Negroes noteworthy. In the first place, it is less than an hour's drive to portions of the Mississippi Delta in which Negro agriculturists working as croppers on large plantations comprise as high as 90 per cent of the total population of some wards. In the second place, the charge is frequently made that Negro farm operators (other than croppers) are to be found mainly in the very poorest agricultural areas.[1] If this were true, they should be well represented in these proposed land-retirement areas. Thus their scarcity here is worth noting. Conversations with the white farmers in the area studied revealed that they were strongly opposed to Negroes settling on the land in this territory, which no doubt accounts for the present scarcity. Only in a few cases, where fairly well-to-do families desired domestic servants, were Negroes welcomed in the open country.[2]

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[1] As the study was being planned, we were seeking a region in which there was a large "stranded" population. When asked about stranded Negro populations in LaSalle Parish one well-informed official stated, "You can't strand a Negro anywhere." His remark is borne out not only by this study, but by a comprehensive study of population changes in Louisiana and a special study of the population changes precipitated by the decadence of the sugar industry in Louisiana. The Negro on the one hand owns so little property and is connected by such weak social ties to a given locality that he is able to pick up and move easily. On the other hand, in many cases his living is so near the subsistence level that he is forced to shift very quickly after unemployment begins. One might say that his migrations are more responsive to economic changes than the migrations of whites.

[2] Kinship is frequently the basis of grouping among the families. In some places three or four brothers and their families were found living in very close proximity. In other instances a man's married sons and daughters have built their homes in the immediate vicinity of the parental roof. Our field workers came to the conclusion that the people who had left these small clusters of blood relatives to settle in other parts of the Ward were much more progressive than those who had remained in the old neighborhood.

4. *Ancestry.*

One of the first things one wants to know about the members of any group is the original stock from which they are descended. Our schedule was framed to try to obtain this information from the people in the area studied. By way of introduction, it should be recalled that LaSalle Parish is one of the "hill" parishes of Northern Louisiana, for this had much to do with determining the type of people who settled there. One of the most important currents of migration in the history of the United States was that which, beginning in Western Pennsylvania and using Philadelphia as its port of entry, pushed down through the uplands in the western parts of Maryland, Virginia, North Carolina, South Carolina, and Georgia, and then spread westward, furnishing with settlers those parts of the South and Southwest which were similar topographically to the western portions of the "seaboard states." The migrants were, and their descendants remain, the "hill" peoples of the South. Originally very heterogeneous in origin (English, Scotch, Irish, and German were probably the elements of greatest importance), they became the "Old Americans" of the Nation. They are the people whose descendants are now found in the hilly portions of the State, the poor and least fertile portions of which are well represented by the area we are studying.

The descent claimed by the families in these hilly sections is "Original American," but of course only those admitting Indian blood, of whom there was a surprisingly large percentage (8.6 per cent), are really entitled to this designation. For all white families, the attempt was made to go further and enumerate the various elements of descent which had entered into their lineage. In most cases where any information on the subject was forthcoming, several national stocks were listed. Many of these families of "Original Americans" remember something of the stocks from which they have come, and proudly informed our field workers of the different elements which had united in the formation of their family trees. A considerable portion, however, was dumfounded at such a question and seemed completely lacking in information about their descent. The initial remark customarily made by those who were hard put to it for an answer to the question concerning descent was, "I'm just plain American." Sometimes the answer, "I don't know,

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[1] See Carter Woodson, *The Rural Negro.*

[2] A similar hostility to Negroes as permanent residents has also been noted in other areas where the productivity of the land is slight. Certain portions of Assumption Parish where the periodic overflow of lands makes them of very little use for agricultural purposes may be cited as an example.

TABLE I.

RESIDENCE OF FAMILIES AND INDIVIDUALS IN WARD THREE, BY RACE

RESIDENCE—	TOTAL			WHITE			NEGRO			INDIAN		
	No. of Families	Individuals		No. of Families	Individuals		No. of Families	Individuals		No. of Families	Individuals	
		Number	Pct.		Number	Pct.		Number	Pct.		Number	Pct.
TOTAL	862	3,385	100.0	531	2,330	100.0	326	1,020	100.0	5	35	100
Farm	225	1,048	31.0	210	973	41.7	11	48	4.7	4	27	77
Woodland Clearing	45	187	6.9	41	162	7.0	3	17	6.5	1	8	23
Sawmill Village	525	1,865	55.1	230	959	41.2	295	906	88.8	0	0	0
Logging Camp	64	273	6.6	47	224	9.6	17	49	.0	0	0	0
Gravel Pit Camp	3	12	.4	3	12	.5	0	0	.0	0	0	0

maybe it's nigger," was offered in a humorous vein,[1] while others responded, "I guess it's Greek, 'cause it's all Greek to me." Some persons insisted that they were just like everybody else and could make no distinction. When some Indian blood was admitted, the caution was usually made, "Be sure you don't put me down all Indian." In spite of the best attempts, a considerable number of families could give no information concerning their descent. However, their names are the same as those of the others residing in the area and stamp them as "Old Americans."

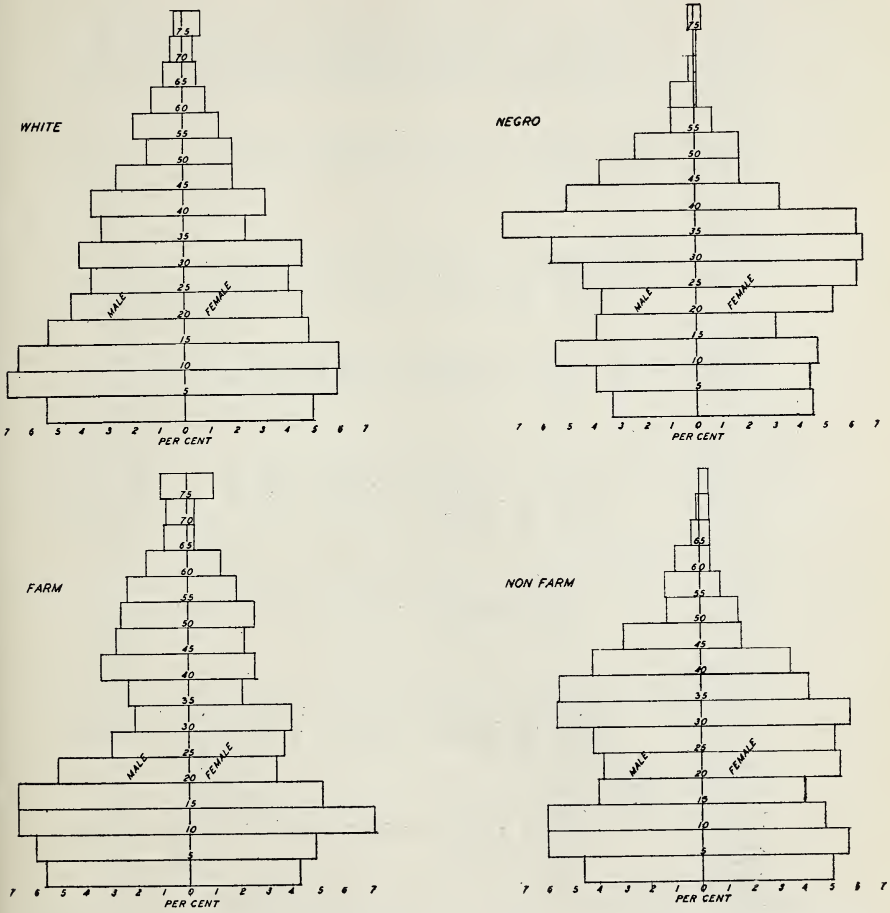

FIGURE 1.—Age and Sex Distributions for the White, Negro, Farm and Non-Farm Populations of Ward Three, LaSalle Parish.

The major elements which have entered into the composition of the group are Irish, English, French, Scotch, Dutch, German, and Indian. Besides these stocks, a smattering reported Welsh, Jewish, Swedish, Italian, and Swiss elements in their lines of descent. For ease of reference the data have been summarized in Table II.

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[1] Of course, for anyone else to make such a suggestion would be considered a great insult.

TABLE II.

THE FREQUENCY WITH WHICH WHITE FAMILIES OF WARD THREE, LASALLE PARISH, MENTIONED THE DIFFERENT STOCKS FROM WHICH THEY CLAIMED DESCENT, CLASSIFIED ACCORDING TO RESIDENCE

DESCENT—	TOTAL		FARM		WOODLAND CLEARING		SAWMILL VILLAGE		LOGGING AND GRAVEL CAMPS	
	Number	Pct. of Known	Number	Pct. of Known	Number	Pct. of Known	Number	Pct. of Known	Number	Pct. of Known
TOTAL	531	100.0	210	100.0	41	100	230	100.0	50	100
Irish	283	60.9	98	51.6	22	63	142	68.9	21	62
English	201	43.2	110	57.9	20	57	58	28.2	13	38
French	81	17.4	19	10.0	3	9	52	25.2	7	21
Scotch	58	12.5	18	9.5	4	11	33	16.0	3	9
Dutch	47	10.1	11	5.8	2	6	33	16.0	0	0
German	46	9.9	15	7.9	2	6	26	12.6	3	9
Indian	40	8.6	13	6.8	1	3	21	10.2	5	15
Welsh	5	1.1	3	1.6	0	0	2	9.7	0	0
Jewish	2	.4	0	.0	0	0	1	4.9	1	3
Swedish	1	.2	0	.0	0	0	1	4.9	0	0
Italian	1	.2	0	.0	0	0	1	4.9	0	0
Swiss	1	.2	0	.0	0	0	1	4.9	0	0
Unknown	66	12.4	20	9.5	6	15	24	10.4	16	32

TABLE III.

AGE AND SEX DISTRIBUTIONS OF THE FARM POPULATION OF WARD THREE, LASALLE PARISH, BY RACE

Age	Total				White				Negro		Indian	
	Male		Female		Male		Female					
	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Male	Female	Male	Female
Total	564	52.9	502	47.1	520	52.8	464	47.2	23	24	21	14
0	60	5.6	46	4.3	53	5.4	43	4.4	2	2	5	1
5	64	6.0	52	4.9	58	5.9	48	4.9	3	2	3	2
10	71	6.7	77	7.2	64	6.5	71	7.2	3	4	4	2
15	72	6.7	56	5.2	67	6.8	51	5.2	3	2	2	3
20	55	5.1	36	3.4	48	4.9	34	3.5	4	2	3	0
25	32	3.0	40	3.7	31	3.2	39	4.0	1	1	0	0
30	22	2.1	43	4.0	21	2.1	39	4.0	1	1	0	3
35	25	2.3	22	2.1	23	2.3	19	1.9	0	3	2	0
40	36	3.4	28	2.6	35	3.6	26	2.6	1	1	0	1
45	30	2.8	23	2.2	28	2.8	21	2.1	1	2	1	0
50	28	2.6	28	2.6	25	2.6	26	2.7	2	1	1	1
55	24	2.3	20	1.9	24	2.4	19	1.9	0	1	0	0
60	17	1.6	14	1.3	16	1.6	14	1.4	1	0	0	0
65	10	.9	3	.3	10	1.0	3	.3	0	0	0	0
70	8	.8	3	.3	8	.8	2	.2	0	1	0	0
75 over	10	1.0	11	1.1	9	.9	9	.9	1	1	0	1

Irish was claimed by the non-agricultural population most frequently, while the memory or fiction of English ancestry was most prevalent among the agriculturists. French ranked third in both groups, which was somewhat surprising, since the hill-folk of Northern Louisiana are popularly considered quite different from the French-speaking people of Southern Louisiana. It is interesting to note that those claiming French descent are concentrated in the lumber industry. And it is probable that this strain is from the French Huguenots, rather than the French Catholics who settled in South Louisiana. Scotch, Dutch, German, and Indian rank next, and are of about equal importance. The other elements are of little consequence.

It will be observed from Table II that a very considerable portion of the families (12.4 per cent) was unable to supply any information concerning their national origins or to enumerate any of the national stocks from which they had sprung. However, as mentioned above, a comparison of their names with the names of the other residents in the area failed to show any significant differences. In a great many cases their names were the same as those of families who made some claim of knowing their descent. And since the reports of the families concerned agree with the historical evidence on the subject, we can be fairly certain of the elements which have entered into the composition of the group. These are all the more important because of the fact mentioned above, that the people in the area are all native-born.

5. *Age and Sex.*

Age and sex are two factors which are of great significance in determining the nature and estimating the possibilities of a given population. For this reason it is important to present the basic facts pertaining to the age and sex distributions of the population in the area we are studying. This is done in Tables III and IV. A conventional graphic device is of great assistance in comprehending the significance of the distributions. In Figure 1 are presented four graphs showing the age and sex distributions of the white population, the Negro population, the farm population and the non-farm population. The Negro farm population is too small to lend itself to this kind of analysis.

Let us examine the major points to be grasped from a study of the configuration of the pyramid for the total population. In the first place there is a marked scarcity of children under 10 and especially under 5. This is indicative of the rapid pace at which the birth rate has been falling. A computation shows only 390 children under 5 for every 1,000 women aged 16 to 44, inclusive.[1] In the second place there is a great concentration of males in the ages 30 to 50 and of females in the ages 30 to 35, probably indicating that opportunities for the employment of developing youth have been very scarce in the last ten years, and/or that the newest and youngest employees were the first to be laid off. It fails to show any pronounced accumulation of rural youth in this area—a tendency often thought to be taking place since the crisis of 1929.

The age and sex distributions for the white farm population are even more revealing: (1) the fall in the birth rate, as indicated by the scarcity of children, has proceeded at a very rapid pace. Of course, the white farm population always has

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[1] A recent estimate gives 360 as the number of children under 5 per 1,000 women aged 16 to 44, inclusive, that would be required to maintain the population stationary. See the *Report of the National Resources Board,* December, 1934, p. 94.

TABLE IV.

AGE AND SEX DISTRIBUTIONS OF THE NON-FARM POPULATION OF WARD THREE, LaSALLE PARISH, BY RACE

Age	Total				White				Negro			
	Male		Female		Male		Female		Male		Female	
	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.
Total	1179	50.8	1140	49.2	683	50.7	663	49.3	496	51.0	477	49.0
0-	106	4.6	117	5.1	74	5.5	73	5.4	32	3.3	44	4.5
5-	139	6.0	133	5.7	102	7.6	90	6.7	37	3.8	43	4.4
10-	140	6.0	112	4.8	87	6.4	68	5.0	53	5.5	44	4.5
15-	93	4.0	93	4.0	56	4.1	63	4.7	37	3.8	30	3.1
20-	88	3.8	126	5.4	54	4.0	74	5.5	34	3.5	52	5.4
25-	97	4.2	120	5.2	53	3.9	57	4.2	44	4.5	63	6.5
30-	131	5.6	134	5.8	75	5.6	68	5.1	56	5.8	66	6.8
35-	128	5.5	97	4.2	52	3.9	36	2.7	76	7.8	61	6.3
40-	98	4.2	81	3.5	48	3.6	48	3.6	50	5.1	33	3.4
45-	69	3.0	38	1.6	32	2.4	23	1.7	37	3.8	15	1.5
50-	30	1.3	35	1.5	9	.7	19	1.4	21	2.2	16	1.6
55-	29	1.3	19	.8	20	1.5	13	1.0	9	.9	6	.6
60-	20	.9	8	.4	12	.9	7	.5	8	.8	1	.1
65-	8	.3	10	.4	6	.4	9	.7	2	.2	1	.1
70-	3	.1	8	.4	3	.2	8	.6	0	.0	0	.0
75 over	0	.0	9	.4	0	.0	7	.5	0	.0	2	.2

been one of the most prolific in reproduction and the more isolated and remote the area, the greater the fertility seems to have been.[1] Nevertheless, in our area the ratio of children to women now stands at only 420 for this element of the population; (2) a heavy current of migration has carried away the majority of the people at the productive ages from the farms, for there is a great scarcity of people aged 20 to 40 in the white farm population; (3) the concentration in the ages 10 to 20 reveals the tremendous burden which the proper education of the young entails upon such rural regions, an education whose benefits are mostly reaped by other areas;[2] (4) there is a marked concentration of population in the ages above 45; and (5) there is little evidence that any pronounced retardation in the migration of rural youths from the area has set in with the depression.

The two distributions representing the white and Negro non-farm populations are rather representative of industrial populations in general. Among the Negroes the concentration of males aged 30 to 45, of females aged 20 to 40, and the scarcity of children and old people are outstanding. At least part of the excess of Negro females is due to a considerable development of prostitution in these sawmill villages. Comments on the scarcity of children frequently elicited the reply that they couldn't be expected to have children since they scarcely had enough to live on themselves. At any rate the ratio of children to women is only 265 among these industrial Negroes. This is far below the minimum necessary to maintain the population.

The distribution for non-farm whites is the most "normal" of the four. There is some scarcity of young adults, especially young males. But the scarcity of children is less pronounced. In fact the ratio of 445 children to 1,000 women is the largest among any of the groups in the population.

All in all the data relating to the age and sex distributions of the population reveal several important facts. In the first place the time seems to have come when even the population in these very remote areas is doing little more than replacing itself. Again the data show the great extent to which migration has carried away the young adults from the area, i.e., a large portion of the population which has most to gain from a resettlement program, on the one hand, and which would contribute most to its success, on the other, has already departed from the area.

6. *Education.*

The educational qualifications or training of the population in this projected land-retirement area is also a very important consideration. It reflects the standards of the group in part, and also throws light upon the type of life which the economic system prevailing in the area can support. Furthermore it helps explain the present situation of the population and serves as one of the best indices for anticipating what to expect of these people in the future.

Two tabulations were made to show the educational status of the population in the area: one for the heads of families, and one for all others of 10 years of age and over who were not attending school at the time of the survey. The data were further subdivided in each case by residence and race. In the tabulations the following eight categories were used: No formal schooling, attended grammar school but did not finish, finished grammar school but did not attend high school, attended high school but did not finish, finished high school but did not attend college, attended college but did not finish, finished at least four years of college work, and not available. In most cases "not available" means no formal schooling. The frequency and percentage distributions for the heads of families are presented in Table V; those for the remainder of the population aged 10 years and over and not now in school are given in Table VI.

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[1] *Ibid.*, p. 94.

[2] Of course, the losses due to lack of proper educational facilities and interests must also eventually fall upon the places to which these people migrate.

To a striking extent the heads of families are lacking in any formal training above that offered in elementary grades. This is particularly true of those individuals making their homes on the farms and in the small clearings in the woods. It is especially true among the colored population but also very evident among the white group. In fact nearly one out of 10 of the heads of the white famliies residing in the open country had no formal training whatsoever, over 60 per cent of them had never completed grammar school, and three-fourths of them had never attended high school. Only one of the 210 had attended college, and he did not graduate. Among the heads of families in the sawmill villages and lumber camps the educational status was somewhat higher. The presence of skilled and supervisory employees as well as professional men in the villages contributed materially to their showing. Among the bulk of laborers, however, the status was also very low.

The educational status of the population not now in school, exclusive of heads of families, is considerably above that of the heads. This is especially true in the case of the white farm population. Of course, to a large extent these people represent a generation that is younger than that of the family heads, but this does not alter the importance of the additional education from the standpoint of a resettlement program.

7. *Religion.*

Extreme devotion to the traditional forms of religion is one of the traits most frequently attributed to the Southern Uplander. In view of this fact it is interesting to know the church affiliations of the people in the area. An index was secured by asking the head of each family to give the church of which he was a member, such information being sufficient for the general purpose of this study.

The Christian denominations mentioned by the various heads of families totaled 11. The Baptist denomination was mentioned most frequently, being indicated by 53.3 per cent of the white and 63.2 per cent of the Negro cases. The Methodist denomination came next, 20.4 per cent of the whites and 8.5 per cent of the Negro cases mentioning affiliation with it. Eight other Protestant denominations were named, including the Church of God and Christ, the Christian, the Presbyterian, the Pentecostal, the Holiness, the Church of Christ, the Church of God, and the Apostolic. All told, however, these eight denominations included only 6.0 per cent of the white and 1.5 per cent of the Negro cases. Only five families of Catholics were found, four of whom were white and one a Negro. No church affiliation was reported by 104 (19.6 per cent) of the white heads of families and 88 (26.5 per cent) of the colored.[1] Included in the colored group, however, were three of the Indian

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[1] In nearly all these cases the individuals interviewed thought it necessary to explain their lack of affiliation with a church. Many referred to the "hard times," and mentioned their inability to make contributions, the absence of transportation facilities, and their lack of proper clothing.

TABLE V.

EDUCATIONAL STATUS OF THE HEADS OF FAMILIES, BY RESIDENCE AND RACE

Educational Status*—	Family Farm				Woodland Clearing				Sawmill Village				Logging and Gravel Camps			
	White		Colored		White		Colored		White		Colored		White		Colored	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Num ber	Per Cent	Number	Per Cent
Total	210	100.0	15	100	41	100	4	100	230	100.0	295	100.0	50	100	17	100
No Formal Schooling	12	5.7	3	20	3	7	2	50	9	3.9	49	16.6	1	2	3	18
Attended Grammar School	115	54.7	11	73	18	44	2	50	78	33.9	185	62.7	19	38	10	58
Finished Grammar School	30	14.3	0	0	10	25	0	0	39	17.0	22	7.4	6	12	1	6
Attended High School	41	19.5	0	0	8	20	0	0	57	24.8	30	10.2	15	30	1	6
Finished High School	6	2.9	0	0	1	2	0	0	18	7.8	0	.0	2	4	0	0
Attended College	1	.5	0	0	1	2	0	0	13	5.7	0	.0	2	4	0	0
Finished College	0	.0	0	0	0	0	0	0	9	3.9	0	.0	1	2	0	0
Not Available	5	2.4	1	7	0	0	0	0	7	3.0	9	3.1	4	8	2	12

*All these categories are mutually exclusive. For example, "Attended Grammar School" means attended grammar school but did not finish. "Finished Grammar School" means that elementary school was completed but high school not attended, etc.

TABLE VI.

EDUCATIONAL STATUS OF THE POPULATION 10 YEARS OF AGE AND OVER, EXCLUSIVE OF THOSE NOW IN SCHOOL AND HEADS OF FAMILIES, BY RESIDENCE AND RACE

	Family Farm				Woodland Clearing				Sawmill Village				Logging and Gravel Camps			
	White		Colored		White		Colored		White		Colored		White		Colored	
Educational Status*	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total No. Individuals	400	100.0	32	100	53	100	10	100	339	100.0	336	100.0	66	100	21	100
No Formal Education	13	3.2	11	34	1	2	5	50	3	.9	38	11.3	2	3	7	33
Attended Grammar School	154	38.5	12	37	17	32	3	30	81	23.9	219	65.2	24	36	13	62
Finished Grammar School	61	15.3	4	13	7	13	0	0	42	12.4	29	8.6	12	18	1	5
Attended High School	110	27.5	4	13	23	44	2	20	112	33.0	39	11.6	21	32	0	0
Finished High School	38	9.5	0	0	5	9	0	0	64	18.9	1	.3	6	9	0	0
Attended College	16	4.0	1	3	0	0	0	0	26	7.7	2	.6	0	0	0	0
Finished College	3	.8	0	0	0	0	0	0	9	2.6	0	.0	1	2	0	0
Not Available	5	1.2	0	0	0	0	0	0	2	.6	8	2.4	0	0	0	0

*All these categories are mutually exclusive. For example, "Attended Grammar School" means attended grammar school but did not finish. "Finished Grammar School" means that elementary school was completed but high school not attended, etc.

TABLE VII.

CHURCH AFFILIATION OF THE HEADS OF FAMILIES, BY RESIDENCE AND RACE

Denomination Affiliated With—	Total				Family Farm				Woodland Clearing				Sawmill Village				Lumber and Gravel Camps			
	White		Colored		White		Colored		White		Colored		White		Colored		White		Colored	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Total	531	100.0	331	100.0	210	100.0	15	100	41	100	4	100	230	100.0	295	100.0	50	100	17	100
Baptist	283	53.3	209	63.2	111	52.9	10	67	27	66	3	75	119	51.7	188	63.8	26	52	8	47
Methodist	108	20.4	28	8.5	51	24.3	3	20	9	22	0	0	39	17.0	23	7.8	9	18	2	12
Other Protestant	32	6.0	5	1.5	10	4.7	0	0	2	5	0	0	19	8.3	5	1.7	1	2	0	0
Catholic	4	.7	1	.3	0	.0	0	0	0	0	0	0	3	1.3	1	.3	1	2	0	0
None	104	19.6	88	26.5	38	18.1	2	13	3	7	1	25	50	21.7	78	26.4	13	26	7	41

TABLE VIII.

MARITAL STATUS OF POPULATION AGED 16 YEARS AND OVER, BY RESIDENCE AND RACE

Marital Status—	Total				Family Farm				Woodland Clearing				Sawmill Village				Lumber and Gravel Camps			
	White		Colored		White		Colored		White		Colored		White		Colored		White		Colored	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Total	1457	100.0	744	100.0	625	100.0	43	100	97	100	9	100	601	100.0	654	100.0	134	100.0	38	100
Married	977	67.0	401	53.9	381	60.9	22	52	65	67	8	89	436	72.5	355	54.3	95	70.9	16	42
Single	377	25.9	109	14.6	193	30.9	13	30	20	21	1	11	136	22.6	89	13.6	28	20.9	6	16
Divorced	10	.7	6	.8	6	1.0	0	0	1	1	0	0	1	.2	6	.9	2	1.5	0	0
Separated	9	.6	82	11.0	5	.8	3	7	0	0	0	0	4	.7	75	11.5	0	.0	4	10
Widow	61	4.2	32	4.3	28	4.5	4	9	7	7	0	0	20	3.3	28	4.3	6	4.5	0	0
Widower	23	1.6	14	1.9	12	1.9	1	2	4	4	0	0	4	.7	13	2.0	3	2.2	0	0
Common-Law Marriage	0	.0	100	13.5	0	.0	0	0	0	0	0	0	0	.0	88	13.4	0	.0	12	32

families. Not Christianized as yet, they undoubtedly retain many of their native religious beliefs and practices. Lack of church affiliation was more pronounced among the families residing in the villages and camps than among those living in the open country. In the villages non-affiliation was also more prevalent among Negroes than among whites. The data tabulated according to residence and race are presented in Table VII.

8. *Marital Status.*

The marital status of a population is another important characteristic in its composition. It is useful in depicting the present situation of a group, on the one hand, and for estimating its possibilities, on the other. Accordingly a tabulation was made for the group we are studying. A refinement was introduced by omitting all persons under sixteen years of age. The categories utilized included the four conventional ones: "married," "single," "divorced," and "separated." The "widowed" class was subdivided to indicate sex. Finally an additional group, "common-law marriage," was added to take care of a large number of Negro couples who were living together "without benefit of clergy." The data given according to residence and race are presented in Table VIII.

III

MOBILITY AND REACTIONS TO PROPOSALS OF REMOVAL

The data and discussion given in Section II have identified the original stocks from which the population of the area is descended, and have summarized some of its important characteristics. Now we may shift our attention to other fundamental aspects of the situation. Let us next consider the extent to which the families in the area may be said to be rooted to this locality, i.e., the extent to which the lives of these people have been identified with this particular area.

This question has an important bearing upon many remedial measures now being undertaken. The land utilization and resettlement programs, and even the rural rehabilitation proposals, all appear to be headed in the direction of rather wholesale transfers of population from one area to another. There is great need for anticipating the success or failure of specific attempts along these lines. It is probable that people whose ties to a particular locality have been slight will be more amenable to voluntary migrations than people whose entire lives and family tradition have been bound up in one limited area.

1. *Residence Confined to the Parish and Ward.*

It has already been shown that no foreign-born persons were to be found in the area, a fact which serves as a starting point in this analysis. Among the data secured in the study were some which enabled us to determine whether or not the heads of the families had spent their entire lives in LaSalle Parish and Ward Three which we are studying. These data were tabulated and are presented in Table IX. In interpreting the findings given in this table, it should be remembered that the heads of families are a very selected group, comprising the very persons from the general population who are most likely to have lived in other localities and formed attachments with other groups. A tabulation for the population as a whole, would, of course, show a higher proportion of those whose lives had been spent in the particular locality, but would be of less significance for the present purposes than the one we give.

TABLE IX.

NUMBER AND PERCENTAGE OF FAMILY HEADS WHO HAVE SPENT THEIR ENTIRE LIVES IN THE PARISH AND WARD, CLASSIFIED ACCORDING TO RESIDENCE AND RACE

Residence and Race—	Number and Percentage Spending Entire Life in			
	Parish		Ward	
	Number	Per Cent of All Family Heads	Number	Per Cent of All Family Heads
Total	220	25.5	99	11.5
White	159	30.0	85	16.0
Colored*	61	18.4	14	4.2
Farm	131	58.2	78	34.7
White	123	58.6	70	33.3
Colored*	8	53.3	8	53.3
Woodland Clearing	18	40.0	12	26.7
White	17	41.5	12	29.3
Colored*	1	25.0	0	.0
Sawmill Village	71	13.5	9	1.7
White	19	8.3	3	1.3
Colored*	52	17.6	6	2.0
Log'g & Grav. Camps	0	.0	0	.0
White	0	.0	0	.0
Colored*	0	.0	0	.0

*Negro and Indian.

Only one-fourth of the family heads had spent their entire lives in LaSalle Parish, and only 11.5 per cent their entire lives in Ward Three. Offhand, these proportions do not seem very high. However, there were considerable differences among the constituent elements which need to be taken into consideration. Nearly 60 per cent of the heads of farm families had never lived outside of LaSalle Parish, and over one-third of them had resided all their lives in Ward Three. This would seem to indicate an extreme attachment on the part of the farm group for this particular locality. Moreover, this is true of both white and colored families. Even two-fifths of the squatters in woodland clearings, people whose attachments to the locality are not of a proprietory nature, had never lived outside the Parish. And over one-fourth of them had spent their entire lives within the limits of Ward Three. It would seem from this that the agricultural population has established strong and intimate ties with this particular locality.

The situation in the sawmill villages and logging and gravel camps was quite different. The data show that the people residing in these villages and camps were pretty largely drawn from outside the Ward and Parish. In fact not a single family head out of the 64 residing in logging and gravel camps came from the Parish. In the sawmill villages only 13.5 per cent of the family heads had lived all their lives in LaSalle Parish. Furthermore, the percentage would not have been this high were it not for the fact that the heads of 52 Negro families were included in the group. Among the whites only 19, of a total of 230, had resided solely in LaSalle Parish. Apparently the lumber industry had brought in white people from other parishes and states to man their mills but had utilized much of the local Negro labor.

2. *Out of Parish Work Records.*

In each interview our field worker attempted to secure a complete work record for the head of the household during the last decade, or since January, 1925. Among the items asked for were: the industries and places in which the work was done, and the occupations of the workers. The information given enables us to gauge fairly well the extent to which the population has remained rooted to one locality, on the one hand, or has floated about from place to place, on the other. This is very important data, bearing on the problem now under discussion, i.e., the probability that attempts at relocating part of the population would be successful.

A tabulation was first made separating the heads of households into three groups: (1) those whose entire work record for the 10 years had been confined to LaSalle Parish; (2) those having a work record in Louisiana parishes other than LaSalle, but not outside the State; and (3) those with a work record outside the State. These data were tabulated separately for each of the residence categories. They are presented in Table X. Since the sawmill villages contained sufficiently large numbers of both Negroes and whites, the information was further subdivided for this group according to race. These data round out the picture presented above. They emphasize the rather extreme degree to which the horizons of the agricultural population have been confined to the immediate neighborhood. They serve warning that strong ties unite the resident farm population to this particular area. At the same time they indicate a looseness of territorial ties among the non-agricultural or lumbering population.

So much for the extent to which the heads of families show work records outside the Parish of LaSalle. But it is also interesting and important to consider the other parishes within Louisiana, and the other States in addition to Louisiana, in which the heads of the families have worked. Let us first consider the families residing on farms. Only 41 of the 210 heads of white farm families showed a work record outside LaSalle Parish. But members of the group showed work records in 21 Louisiana parishes and in the States of Alabama, Arizona, Arkansas, California, Illinois, Iowa, Mississippi, and Texas. Nine showed work records in Texas and four in Arkansas; otherwise each state was represented by only a single case. Among the heads of Negro and Indian farm families, only one showed an out-of-Parish work record. This individual had worked in three neighboring parishes: Catahoula, Grant, and Rapides.

In order to assist in securing a better picture of the situation, Figure 2 was prepared. It gives a graphic summary of the parishes in which the heads of white and Negro farm families worked during the decade 1925 to 1935, and should be compared with Figures 3, 4, and 5, which give comparable data for the heads of families residing in woodland clearings, sawmill villages, and logging and gravel camps. It will be noted that the work records outside the Parish are comparatively rare for the heads of farm families, and that the few instances that do occur are mostly limited to the parishes immediately adjoining LaSalle. Practically no reports of work in Southern Louisiana were given.

TABLE X.

FREQUENCY DISTRIBUTIONS SHOWING THE EXTENT TO WHICH THE HEADS OF HOUSEHOLDS HAVE WORK RECORDS OUTSIDE LaSALLE PARISH

Present Residence—	Total Number of Families	Work Record Confined to LaSalle Parish		Work Record in Other Louisiana Parishes but Not in Other States		Work Record Outside of Louisiana	
		No.	Pct.	No.	Pct.	No.	Pct.
Total	862	455	52.8	279	32.3	128	14.9
Farm	225	183	81.4	28	12.4	14	6.2
Woodland Clearing	45	26	57.9	15	33.2	4	8.9
Sawmill Village	525	243	46.3	177	33.7	105	20.0
White	230	97	42.2	82	35.6	51	22.2
Colored	295	146	49.5	95	32.2	54	18.3
Logging and Gravel Camps	67	3	4.5	59	88.0	5	7.5

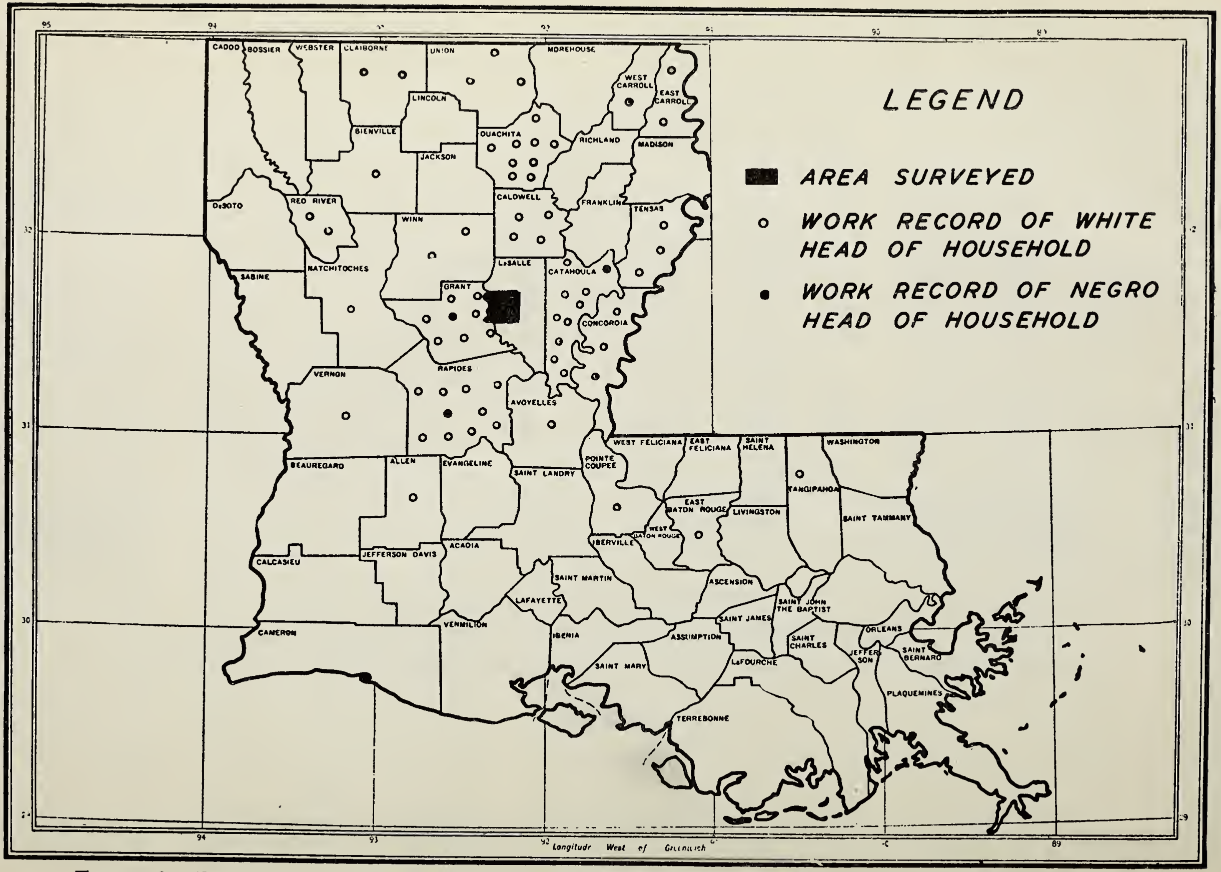

Figure 2.—Distribution of the Work Records of the Heads of Farm Households, by Race, 1925 to 1935.

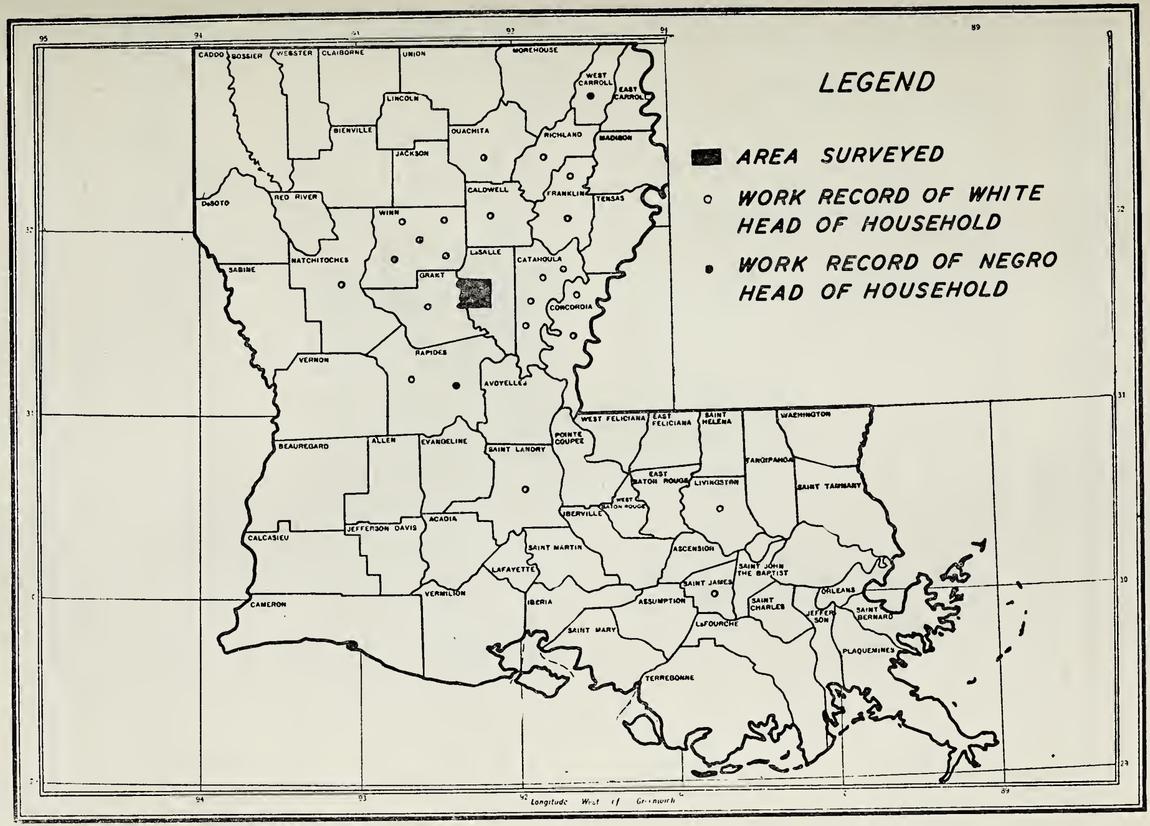

FIGURE 3.—Distribution of the Work Records of the Heads of Woodland Clearing Households, by Race, 1925 to 1935.

The situation in the woodland-clearing cases is very similar, only 18 of the 41 heads of white families reported having been employed outside the Parish. Of these, four had worked outside the State, one each in Arizona, Mississippi, Ohio, and Texas. Work records in 14 other Louisiana parishes were mentioned (see Figure 3). As in the case of the farm families, the parishes mentioned are confined to Northern Louisiana and are mainly those adjacent to LaSalle. Only one of the three Negro cases in this category had worked outside the Parish, and this was in the neighboring Parish of Rapides.

In sharp contrast to the two groups just discussed, is the situation among the sawmill-village, logging-camp, and gravel-camp families. Nearly three-fifths (58 per cent) of the heads of white families who were residents of sawmill villages and over one-half (51 per cent) of the Negroes had work records outside LaSalle Parish. The 51 heads of white households with work records outside the State had been employed in Alabama, Arkansas (14 instances), California, Florida, Georgia, Mississippi (14 instances), Missouri, New York, Tennessee, Texas (17 instances), and Washington. The 54 Negro heads reported working in the States of Arkansas (20 instances), Arizona (2 instances), Washington, D. C., Florida, Illinois, Indiana, Kansas, Kentucky, Mississippi (9 instances), Missouri, Ohio, Oklahoma (3 instances), South Carolina, Tennessee (2 instances), and Texas (12 instances). Likewise 38 Louisiana parishes other than LaSalle were listed by the whites and 30 parishes by the Negroes. These parishes were much more widely distributed throughout the State than in the case of the farm and woodland-clearing groups. A liberal sprinkling of work records was reported for the South Louisiana parishes (see Figure 4).

The situation among the dwellers in the lumber and gravel camps was similar. Of the heads of white families only 6 per cent reported no work record outside LaSalle Parish. Out-of-State work records were reported in seven instances: three in Arkansas, two in Mississippi, and one each in Oklahoma and Texas. In addition, work records in eleven other Louisiana parishes were reported by members of this group. Among the heads of Negro families of the lumber-camp group not a single one failed to report an out-of-parish work record. Four individuals reported out-of-State work records: two in Arkansas and two in Texas. In addition, work records in 14 other Louisiana parishes were reported by members of the group. The distribution of these, together with those for the corresponding group of white people, is shown in Figure 5.

3. *Reactions to Proposals of Removal.*

The data we have presented and the discussion given of them seem to indicate a rather extreme attachment on the part of the farm families for this particular locality. Although this attachment is not matched by the famiiles gaining their livelihood from the lumber industry, it has great significance for the remedial measures now being attempted by governmental agencies. A land utilization or resettlement program will probably find the agricultural population the most difficult factor in the total situation. Their attitude towards the suggested programs will determine, in the last analysis, its success or failure.

In view of this, it is interesting to note at this point the reactions of the population in Ward Three to the proposals of removal. In the course of the interview each head of a family was asked if he would be willing to move to some other locality in which the farm lands were better or opportunities greater. A chance to dispose of present holdings and help to begin anew were included as

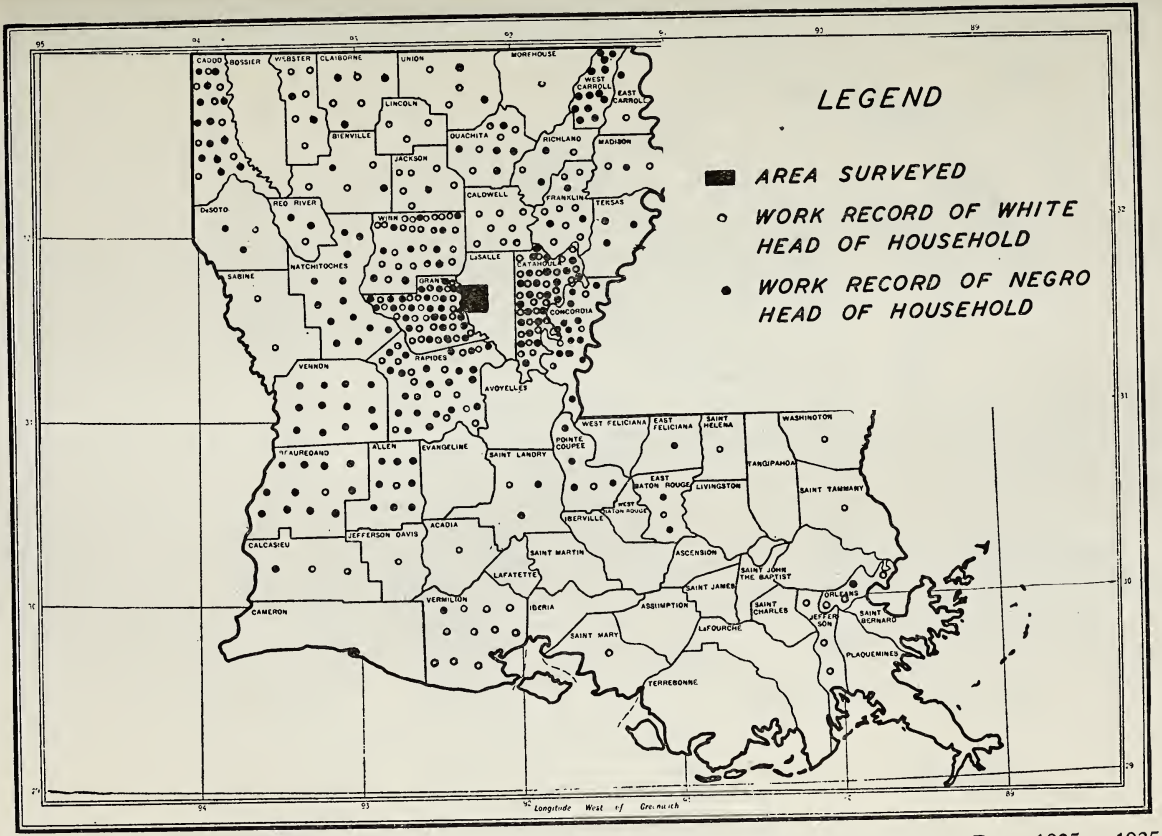

FIGURE 4.—Distribution of the Work Records of the Heads of Sawmill Village Households, by Race, 1925 to 1935.

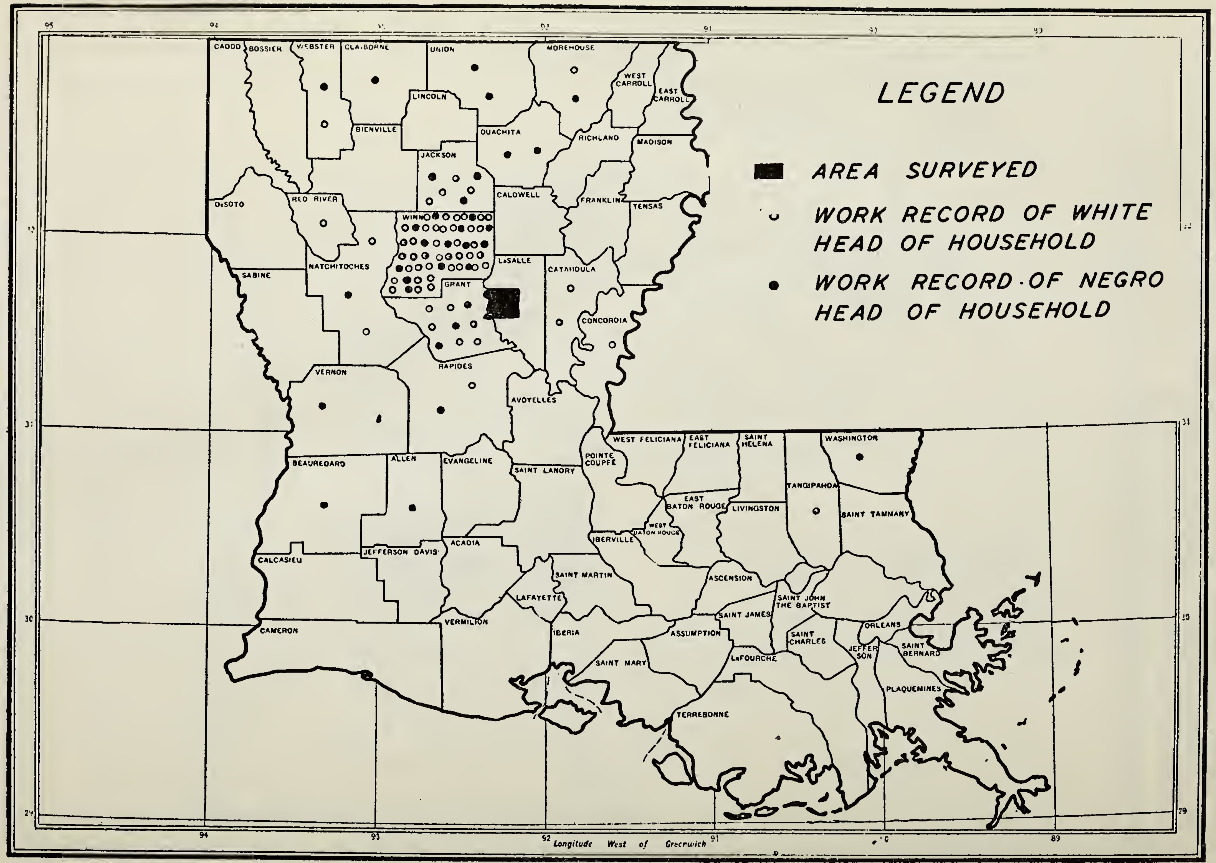

FIGURE 5.—Distribution of Work Records of the Heads of Lumber and Gravel Camp Households, by Race, 1925 to 1935.

conditions in the proposal. On the basis of replies to these questions, the interviewer classed each family as willing or unwilling to move. These data are assembled in Table XI, where their relationship to the factors of race and residence are also indicated. On the whole, opinion on the matter seems rather evenly divided, although large proportions of the farm families and of the white families expressed their unwillingness to make a change of residence.

Among the 210 white families residing on the farms were 125 families which secured the major portion of their subsistence from agriculture and which also contained an able-bodied male member over 15 and under 50 years of age. Offhand this would appear to be the group of families to which a resettlement program would have the most to offer, and which would make the best prospects for the inauguration of a successful project. Therefore, additional data concerning this group are presented. Of the 125 families, only 45, or 36 per cent, expressed a willingness to move to more favorable surroundings. The remainder declared they were unwilling to make the change.

At first it might be thought that these families were faring very well where they were, and for this reason did not desire to change. It should be noted, however, that 92 of the 125 families, or 73 per cent, were either receiving relief at the time of the interview, or had previously been on the rolls of the Federal Emergency Relief Administration. A tabulation showed that only 37 cases, or 40 per cent, of the families with a relief history were willing to move and that only 24 per cent of the non-relief cases were willing to try new surroundings. Among the 92 families with a relief background, 66 were the owners (at least nominally) of their farms, while the remaining 26 families were tenants. Of the owners with relief histories only 18, or one-fourth of the total, were willing to move, while of the tenant families of similar background 18, or 73 per cent, desired to make a change. Thus ownership of property seems to be a significant bond tying the families to the region, even though the returns from their land have not been sufficient to support them without assistance from relief agencies. On the other hand the tenants seem anxious to get away to more favorable situations. Of course, aimless shifting from one place to another on the part of some of the families may explain both why they remained as tenants and were in need of relief on the one hand, and why they were willing to move from their present location, on the other.

Unfortunately the number of Negro cases is too small for a comparable analysis to be of much significance. Among the 10 Negro farm families whose major source of support was agriculture, eight also contained an able-bodied male over 15 and under 50. All eight had a relief history. Four were willing to move, four unwilling. Of four owners, two were willing to move, and of four tenants, two were agreeable to a change.

Fifty-six white families resided on farms but received the majority of their subsistence from non-agricultural sources. Of these, 48 contained an able-bodied male; and of the 48, 22 had a relief background. Of these relief cases only eight (36 per cent) were willing to move. Of the non-relief cases only 6 (23 per cent) were willing to migrate. Among the relief cases six were owners, none of whom was willing to move, while eight, or one-half, of the tenants were anxious to try new surroundings.

The families residing in small clearings in the woods, but not operating farms, form an important group to study. Neither regularly employed in industry or agriculture, nor owning the small clearings in which they reside, they are in the

TABLE XI.

NUMBERS AND PERCENTAGES OF FAMILIES EXPRESSING WILLINGNESS TO MOVE TO OTHER AREAS, BY RESIDENCE AND RACE

Residence—	All Families			White			Colored*		
	Total Number	Willing to Move Number	Willing to Move Per Cent	Total Number	Willing to Move Number	Willing to Move Per Cent	Total Number	Willing to Move Number	Willing to Move Per cent
Total	862	433	50	531	253	48	331	180	54
Sawmill Village	525	263	50	230	107	46	295	156	53
Family Farm	225	98	44	210	90	43	15	8	53
Woodland Clearing	45	26	58	41	24	59	4	2	50
Lumber Camp	64	44	69	47	30	64	17	14	82
Gravel Camp	3	2	67	3	2	67	0	0	0

*Negro and Indian.

most insecure and precarious situation of any group in the area. They, above all people, would seem to have most to gain by any program which would aid in getting them established on lands which they might cultivate. There were 41 white families classed as belonging in this category, and among them were 34 containing an able-bodied male over 15 and under 50 years of age. As might be anticipated, all but seven of the families had a relief background. Nineteen of the 27 cases, or 70 per cent, were willing to move. Of the seven non-relief cases, only 3 were willing to move.

All in all it would seem that the farm tenants and families living in small woodland clearings (mostly squatters) are anxious to try again in new surroundings. Of course, in many instances the same set of causes which led them into their present circumstances might lessen their chances of success elsewhere, but on the other hand some, if given more opportunity, might in the course of time establish themselves securely upon farmsteads of their own. Owners of farm properties, however, despite the meager returns they receive and notwithstanding their dependence upon the relief agencies, say they are unwilling to participate in any program which would involve their transfer to a more promising territory.

IV.

THE ECONOMIC SITUATION IN THE AREA

We have completed a rather detailed description of the population in Ward Three of LaSalle Parish, a selected land-retirement area. Some of the data given have brought out the magnitude of the problem in terms of quantity and density of population. Other information presented has summarized the major characteristics that are useful in denoting the qualitative aspects of a population. All of this material takes on added significance when related to the prevailing economic situation in the area. To this we next turn our attention.

Let us commence by outlining some of the most basic conclusions which have emerged from a careful study of the data gathered by our enumerators. In the first place, one cannot avoid recognizing that the entire population, even that residing on the farms in the area, has been largely dependent upon the lumber industry for support. That is why the timber resources have been of such paramount importance to the entire region, and why the exhaustion of these resources is fraught with such serious consequences. In the second place, one is forced to conclude that the standard of life made possible by the customary agriculture of the region, even when combined with some supplementary income from the lumber industry, has been very meager. Thus at the present time it seems that we have a situation in which the resident farm population, with a lifetime of schooling in the agricultural techniques of the region, even with some improvements on their lands and having some livestock and equipment to work with, are unable to support themselves without assistance from public or private relief agencies. Experience in other areas tells us that as soon as the mills "cut out" and shut down, large numbers of the sawmill laborers and their families will be forced into the surrounding lands, no matter how poor the area may be for agricultural purposes. This occurs for want of any other means of gaining a livelihood. It is a very grave situation. These people have had no agricultural experience in many cases; they have no ready-made improvements with which to start; they have no livestock and equipment to work with; and they most probably have no funds to assist in making a beginning. How can we expect them to be successful as agriculturists in this area? Are we to anticipate that they are to be more fortunate in wresting a living from the sterile soils in this region than the present farm population has been? If not, do we realize that, while the onset of adversity may strike these individuals first, in the end, the Parish, the State, and the Nation will bear the cost? People whose spirits are broken in the struggle against overwhelming odds become a great burden for any society to bear.

1. *Dependence upon the Lumber Industry.*

The extreme dependence of the people in the area upon the lumber industry is easily shown. To begin with, 589 of the 862 families in the Ward, or 68 per cent of the cases, resided either in the sawmill villages or in lumber camps. Except for a few professional people, the sole employment of the breadwinners in these families was in the lumber industry. For example, our investigators found 230 families of white people residing in the sawmill villages. The heads of 170 of these cases, or 74 per cent, found their sole employment in the lumber industry. In addition 25 others had once been employed in this occupation. Of these, at the time of the interview, 11 were on the relief rolls, seven were unemployed, three were clerks in stores, two were occupied in agricultural pursuits, one was a postmaster, and one was employed in the oil fields. At the time of the interview, the occupations of those heads of families who had not been engaged directly in lumbering were as follows: clerks in retail mercantile establishments, nine; housewives, seven; teachers, three; physicians, two; ministers, two; mechanics, two, and butcher, railroad agent, postmaster, rural mail carrier, and barber, one each. In addition, two others were on the relief rolls and one in the Civilian Conservation Corps.

The heads of the 295 Nego families found residing in sawmill villages obtained their only gainful employment in the lumber industry in 220 instances, or 76 per cent of the cases. Thirty-five others, another 12 per cent, formerly were employed full time in sawmilling. At the time of the interview, 18 of the Negro family heads were entirely unemployed, 27 others were on the relief rolls, 15 were in domestic service, five kept rooming and boarding houses, two were working as railroad laborers, one was in a Civilian Conservation Corps, and one was engaged in each of the following occupations: cobbler, porter, janitor, butcher, painter, preacher, and farm cropper. Twenty-five of those on relief had been in the lumber industry, as had six of the unemployed, and the porter, the cropper, the cobbler, and the man in the Civilian Conservation Corps.

Quite naturally the situation in the lumber camps is one of even more direct dependence upon the lumber industry, 44 of the 47 heads of white families being employed solely in this enterprise. Two others recently gave up lumbering, one to enter the mercantile business and the other because of disabilities. The head of the remaining family is a physician. Besides the whites, there were 17 Negro families residing in the lumber camps. In 14 instances the heads of these families were employed solely by the lumber company at the time of interview, as the other three had been in the past. Of the three, one was unemployed, one disabled, and the third on the Emergency Relief Administration rolls, at the time of the interview.

The importance of lumbering to the farm population is also easily shown. In the first place, the heads of 22 of the white families residing on farms were employed in the lumber industry at the time they were interviewed. This is more than 10 per cent of the 210 cases. The heads of another 74 families, or 35 per cent of the cases, although now engaged full-time in farming, had, within the past 10 years, been employed full-time in the lumber industry. In addition, our enumerators found residing on farms but not gaining their support from agriculture, 31 other families whose heads had once been full-time employees in the lumber industry. These three groups total 127 families, or comprise over 60 per cent of the white cases which were found residing on farms. Thus there remain but 83 cases of those families who have not received full-time employment in the lumber industry at some time during the last 10 years. Three-fifths of the white families residing on farms are either engaged directly in the lumber industry at the present time, or have been so employed in the very recent past.

The four families of Indians found living on farms were full-fledged agriculturists. However, among the 11 Negro farm families was one whose head was employed in the lumber industry at the time of interview, while the heads of six other Negro families had recently lost their jobs at the sawmill and taken up agriculture.

The situation among the families residing in small woodland clearings is also interesting. Of the white families, 41 were classified into this residence category. The heads of nine of them were employed in the lumber industry, at the time of interview, while the heads of 12 others were former sawmill employees. The heads of two of the three Negro families were employed in the lumber industry at the time of interview, and the other one was formerly so engaged. The head of the single Indian family in this category had likewise lost his job at lumbering and turned to agriculture.

2. *Incomes.*

Let us next present our data pertaining to the annual incomes of the families living in the open country (farms and woodland clearings) in order to show the very meager living which these people have been able to obtain from their efforts in this area. The families in the open country are the important ones from the standpoint of a resettlement program because, in all probability, their mode of life also furnishes us with a prototype of that to which the entire population will be forced as soon as the mills cut out. Indeed, unless new enterprises are developed, the picture will be even darker when the lumber industry, which now makes considerable contributions to the living of the people residing in the open country, will not be there to supplement the returns from agriculture.

Our investigators asked for and received a summary from most families of the gross income for the preceding year. The source of the income and the member contributing the earnings were also learned. Occasionally a family was reluctant about giving this information, and some families were found who were unable to give even a rough estimate of their earnings; but in general the people made a serious attempt to give reliable and accurate data relating to their incomes.

Much of the income was from the sale of farm products. Since very few families kept books, and since some families could not or would not give the information desired, no elaborate analysis of the data is justified. We merely present the information in form of frequency tables. No averages were calculated. Percentages were computed and are given to assist the reader in summarizing the information. More refined techniques are unnecessary, since these tables clearly reveal the meager-

TABLE XII.

DISTRIBUTION OF INCOMES AMONG THE FAMILIES RESIDING IN THE OPEN COUNTRY, BY RACE

Gross Yearly Income—	All Families		White Families		Colored Families	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total Number of Families	270	100.0	251	100.0	19	100
Unknown	24	8.9	24	9.6	0	0
Under $100	31	11.4	26	10.3	5	26
$ 100-	63	23.3	55	21.9	8	42
200-	59	22.0	55	21.9	4	21
300-	19	7.0	19	7.6	0	0
400-	15	5.5	13	5.1	2	11
500-	11	4.1	11	4.4	0	0
600-	11	4.1	11	4.4	0	0
700-	9	3.4	9	3.6	0	0
800-	5	1.9	5	2.0	0	0
900-	2	.7	2	.8	0	0
1000-over	21	7.7	21	8.4	0	0

TABLE XIII.

DISTRIBUTION OF INCOMES AMONG THE WHITE FAMILIES RESIDING IN THE OPEN COUNTRY, BY INDUSTRY

	Agriculture		Lumber		All Others	
Gross Yearly Income—	No. of Families	Per Cent	No. of Families	Per Cent	No. of Families	Per Cent
Total Number of Families	163	100.0	31	100	57	100
Unknown	20	12.3	3	10	1	2
Under $100	20	12.3	0	0	6	11
$ 100-	43	26.4	0	0	12	21
200-	38	23.3	2	6	15	26
300-	5	3.1	9	29	5	9
400-	2	1.2	8	26	3	5
500-	8	4.9	1	3	2	4
600-	7	4.3	1	3	3	5
700-	3	1.8	3	10	3	5
800-	2	1.2	3	10	0	0
900-	2	1.2	0	0	0	0
1000-over	13	8.0	1	3	7	12

ness of incomes obtained by the families in the region. The specific data as tabulated are given in Tables XII and XIII. Since the number of Negroes and Indians was so small they were combined as "colored." The number of white families was large enough to justify a breakdown by industries; this is done in Table XIII. These data leave no doubt that the incomes in the area are very slight.

3. *Relief.*

In spite of the fact that the incomes of the families in the area are seen to be very meager, some other considerations are necessary for a thorough understanding of the situation. It must be remembered that these gross incomes include, besides the earnings received from agriculture, funds derived from employment in the lumber industry, and the assistance received in the shape of "direct relief" and "work relief" as well. This relief has been no inconsiderable item in comparison to the total. Of the 210 white families residing on farms, 101 were either on the relief rolls at the time of the interview or showed a relief history. The same was true in nine of the 11 Negro cases, and two of the four Indian families. Thus a total of 112 families, or one-half of those living on farms, was either on the relief rolls at the time of interview or had received relief during the past two years. The picture was similar among the families residing in woodland clearings, where 29 of the 41 white families were either on the relief rolls at the time of the interview, or had a relief history in the past three years. However, only one of the four colored families in this class showed a relief history. During the first month of our survey, January, 1935, 84 of the white families living in the open country were on relief. Sixty-seven of these were residents of the farms; 17 lived in the woodland clearings. Four of the colored families were on relief during the first month of the survey. The funds granted during this month for relief purposes aggregated $1,318.71, of which $1,250.70 (sixteen dollars per family) went to the white cases and $68.01 (seventeen dollars per family) went to the colored cases. In addition to the direct and work relief, approximately 100 cases in this Ward also received "Oat Loans" from the Emergency Relief Administration.

In connection with the dependence upon others indicated by the high index of relief in the area, another point should be brought out. Many families maintained gardens, 24 of which were an acre or more in extent. These supplied a considerable portion of the food consumed by the family. But among the white farm families were 13 instances in which absolutely no pretense of planting a garden was made. Likewise 13 of the white families living in woodland clearings made no gardens whatsoever. Many other families had a garden in name only. This would seem to indicate that lack of a will to do for themselves was at the seat of the trouble in some of the cases, because throughout the area are spots of soil which yield excellent returns to the gardener.

4. *Smallness of the Farms.*

Other data relative to the economic status of the farm families can now be given. They are of particular importance for sizing up the economic status of the agriculturists, but they also serve to account for the low incomes obtained by these families. The size of the farming unit operated, and especially the number of acres cultivated by a farmer, are of great value in obtaining a comprehensive understanding of the situation in the area. Likewise the acreage in cotton, which is the chief cash crop grown, is important. Accordingly Table XIV was prepared. The frequency with which given acreages are operated, cultivated, and devoted to cotton are shown in this table. The data are presented separately for the white and colored farm operators.

The data presented in Table XIV show the exclusive manner in which the small farm has constituted the prevailing agricultural unit in the area. Less than 30 per cent of the farms contained as many as 50 acres; only about one-fourth of the farm operators actually cultivated as many as 20 acres of land; and on more than one-half of the farms less than five acres of the chief cash crop, cotton, were planted. This situation, minute farms in a territory of low productivity per acre, represents the basis of the fundamental maladjustment in the territory. It deserves further elaboration.

One very successful agricultural unit combines small farms, fertile soils, and intensive cultivation. But on the other hand, some farmers have the ability to manage profitably large areas of relatively unproductive lands by the use of extensive methods of cultivation. Unless special factors are operative to modify the situation, it is poor economy to cultivate fertile areas extensively, or relatively infertile land intensively. This region has neither particular climatic advantages nor favorable location with regard to transportation facilities and markets, which would give economic justification to the prevalence of small farms in an area of such low productivity.[1] Under modern conditions profitable utilization of the resources of the area can be secured only on an extensive basis. The system of farming suited to the area would seem to include, in addition to extensive operations: (1) the placing of great emphasis upon the production of feed and especially food crops; (2) the expansion of livestock enterprises to become one of the major elements in the farm program, and the devotion of large acreages to pasture; (3) the retention of cotton as a cash crop, but reducing it to secondary importance in the agricultural combination; and (4) supplementing the income from the cultivation of crops with that obtained from timber products, especially pulpwood, which could be grown on part of the land. It should be stressed, however, that, under almost any circumstances likely to exist within the lifetime of the present generation, the agricultural possibilities of the entire region are very limited. There are good spots along the creek bottoms which, with proper protection from floods and adequate drainage, can serve as a nucleus about which extensive operations might be organized. But these are limited in number and size. On the whole, the agricultural prospects of the territory are decidedly unpromising.

5. *Adjudication of Lands for Taxes.*

The inherent sterility of the territory and the maladjustments occasioned by the devotion of the area to the present system of farming are further evidenced by the excessive adjudications of lands for taxes which have occurred in this Ward. The total area of the Ward amounts to approximately 65,000 acres. An analysis recently made[2] showed that the Ward contained approximately 36,000

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[1] In another place, *The Southwestern Review, Summer,* 1935, pp. 392-398, the senior author has discussed the genesis of this maladjustment. It would seem that the changing means of subsistence, the increasing density of population, the differential birth rate, and the nature of the process of migration, have combined to bring about the present unfortunate situation in large portions of our Southern Uplands. Once generated and in existence the system perpetuates itself as a vicious circle.

[2] By Mr. J. P. Montgomery, State Land Planting Consultant for the National Resources Board, to whom we are indebted for these data.

TABLE XIV.

NUMBER OF ACRES OPERATED, CULTIVATED, AND PLANTED TO COTTON BY THE FARM OPERATORS OF WARD THREE, LaSALLE PARISH, BY RACE

Number of Acres—	Acres Operated			Acres Cultivated			Acres in Cotton		
	White Number	Per Cent	Colored Number	White Number	Per Cent	Colored Number	White Number	Per Cent	Colored Number
Number of Farm Operators	157	100.0	13	157	100.0	13	157*		13*
Under 5	1	.6	0	15	9.6	1	85	54.1	9
5-9	6	3.8	0	24	15.3	2	39	24.8	1
10-14	12	7.6	2	36	22.9	4	4	2.5	1
15-19	9	5.7	4	41	26.1	2	3	1.9	0
20-24	25	16.0	0	19	12.1	2	0	.0	0
25-49	58	36.9	4	18	11.5	2	2	1.3	0
50-99	30	19.2	1	1	.6	0	0	.0	0
100-199	11	7.0	2	3	1.9	0	0	.0	0
200-over	5	3.2	0	0	.0	0	0	.0	0

*Twenty-four of the white and two of the colored farm operators grew no cotton.

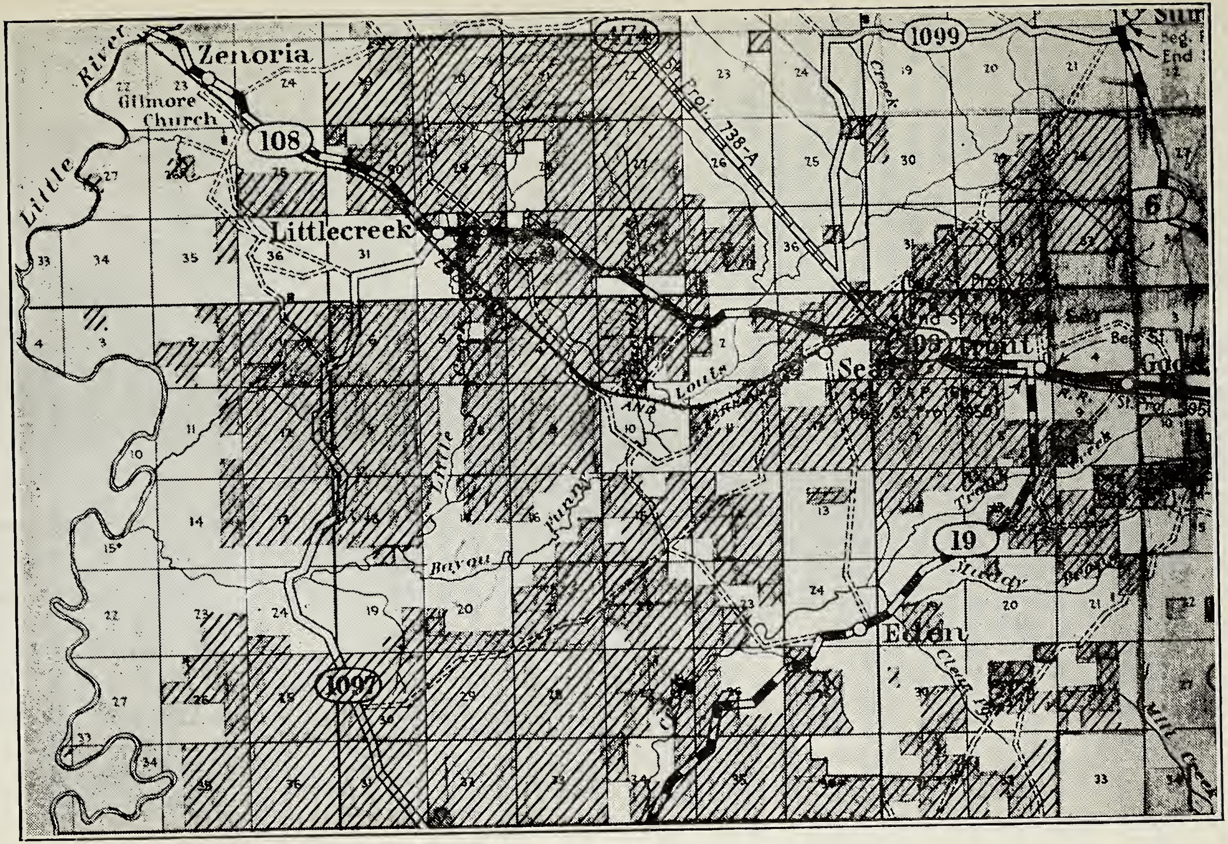

FIGURE 6.—Distribution of the Lands in Ward Three of LaSalle Parish which were Adjudicated to the State for Non-Payment of Taxes and were Unredeemed on November 15, 1934.

acres of land which had been adjudicated for taxes and was unredeemed on November 15, 1934. Thus the lands adjudicated for taxes and unredeemed up to this date amount to over 55 per cent of the total area of the Ward.

The distribution of these properties which have reverted to the State is very interesting. In Figure 6 the location of all the adjudicated lands, not redeemed by November 15, 1934, are plotted. It will be observed that the lands not adjudicated are strung out along the small streams, rivers, and creeks, which flow through the Ward.

Of course, excessive tax schedules might produce high rates of tax delinquency and land adjudication in very fertile areas. Such is not the explanation of the excessive rates in LaSalle Parish, however. The tax here was 45 mills on the dollar, which was above that in 37 and below that in 26 other Louisiana parishes. It was but a fraction of that in such parishes as Lafourche, where it was 271 mills, or Terrebonne, where it was 289 mills. It was less than half of the figure (95 mills) in Vernon, a more comparable region, and one in which adjudication of lands was also excessive. Similarly the tax per acre was small, only 14½ cents per acre, which was less than that prevailing in all Louisiana parishes except Caldwell, Grant, and St. Mary. The adjudicated lands in LaSalle were assessed for an average of $3.22 an acre. The seat of the difficulty probably lies in the fact that there was not a great spread between assessed values and real values, or, in other words, the inherent sterility of the lands is so great that it is not worth much more than $3.22 an acre.

V.

RETROSPECT, PROSPECT, SUMMARY, AND CONCLUSIONS

A tremendous program is now underway, designed to bring about a more equitable adjustment between the population and the land resources of the Nation. A very important part of this program goes under the heading of resettlement and has as one of its chief objectives the transference of families from lands which are hopelessly below the margin in productivity, to areas of more fertile and productive soils. Much investigation has been carried on for the purpose of mapping these "trouble areas," and a report has been published by the National Resources Board showing their location and calling attention to the hopelessness of the economic situation which prevails in them. In the South generally, and in Louisiana particularly, these areas, which are recommended for retirement from agricultural usages, are located in the rolling, pine-hill country, most of which is now "cut over."

The people in these proposed land-retirement areas are in a very sorry plight, although there was a time when they were in rather comfortable circumstances. Some consideration of the genesis of their distressed situation is necessary for an adequate evaluation of the problem or an intelligent inauguration of remedial measures. At the time when self-sufficiency was the rule in agriculture, these regions offered a more promising haven to the pioneer family than the areas which are now recognized as the most fertile and productive. In fact the pioneer families wended their way westward through the fertile delta of the Mississippi River to settle in the very hills from which it now seems socially justifiable to dislodge their descendants. The situation at that time was very different, and the pioneers were making the right choice. Good drinking water was a primary consideration for the welfare of the pioneer family; security from malaria was another; abundance of game was very essential; and hardly any region could be found in which there were not enough patches of fertile soil to produce all the corn needed to supply the family with breadstuffs. The pioneer family found its ideal situation in the hills. It mattered little to it that the bulk of the land was covered by a light, shallow topsoil, one incapable of continued cultivation.

In the course of a few generations, however, the situation was entirely altered. New settlers and the high rate of natural increase caused the density of population to mount speedily. As the cabins and clearings became more numerous the game was rapidly killed off or frightened away. Meanwhile social changes were occuring which brought about a decrease in the self-sufficiency of the household and a greater emphasis upon commercialized farming. To meet increased demands, additional acres had to be cleared and devoted to cotton, the principal cash crop of the region. Clearing up more of the hillsides only served to expose their unprotected surfaces to the frequent, hard, dashing rains which fall throughout the entire year, and the thin covering of topsoil was rapidly carried away. When the forests were gone the rapid run-off of rain water caused frequent floods in the lowlands along the creek bottoms, thus largely destroying their usefulness for agricultural purposes. The returns from the land became smaller year after year. Thus as the population grew and increased, nature's bounties became less plentiful, and as more and more emphasis upon commercialized agriculture became essential, the lands of the area became less and less capable of producing the customary crops. In the course of a few generations the location which was ideal for the pioneer became one of hopelessness for his descendants. At the present time, when attempts are underway to remove the land from agricultural usages, a large population is practically stranded, eking out its very meager existence only with the help of continued public and private aid.

The present study was designed to secure and assemble the pertinent facts relating to the quantity, quality, and present situation of the population in a selected land-retirement area in the State of Louisiana. The area chosen for investigation contained 862 families, or 3,385 individuals, at an average density of 32 persons per square mile. However, 2,138 of the individuals belonged to the 589 families which resided in the sawmill villages and logging camps and were directly dependent upon the lumber industry. They were not attached to the soil as agriculturists in any way. In the open country there were only 1,247 individuals, members of 273 families, or an average density of about 12 persons per square mile. Most of these families had some property rights in the lands they occupied, which means they are the ones with whom a resettlement program will have to deal. Thus we can say that in this area an average number of 12 persons (2.6 families) is involved with each square mile of territory. Of course, this includes the land held by the lumber companies, much of which is devoid of settlers. It should be recognized, however, that prevention of settlement on poor lands must go hand in hand with the resettlement of families residing in submarginal areas.

The population living in the open country was almost exclusively of the white race, although large numbers of Negroes were found in the sawmill villages. It is important to note that this white population was all native-born. These people are representative of the hill peoples of the South—"Original Americans," formed from a blend of English, Scotch, Irish, German, French, and many other stocks. Approximately one family out of 10 stated that Indian blood flowed in their veins. Many of the people in the area had lost all knowledge of their ancestry. The religious affiliation of the families was almost exclusively Protestant—Baptist and Methodist being the predominant denominations. The formal educational training of these people had been very slight. Large numbers had never attended school, and the majority had attended the grade school only.

Analysis of the age and sex distributions and of the marital status of the population revealed several things of importance to a resettlement program. A great dearth of young adults was evidenced both in the open country and in the villages and camps. This means that the people who might gain most from the resettlement program, on the one hand, and contribute most to its success, on the other, are very scarce in the area. Again the number of children when related to the number of women of childbearing age revealed that the population of the area—even that of the farm population—is no longer increasing at a rapid rate but only approximately replacing itself. This means that the natural increase of population in the Ward will neither make for a rapid increase in the area nor furnish a source of supply for other places.

Analysis of the extent to which the people of the Ward had lived and worked in other places showed that the open country population had been rooted to this particular locality in a very high degree. The data emphasized the rather extreme manner in which the horizons of the agricultural population had been confined to the immediate neighborhood, and evidenced the strong ties binding the population to this particular area. In view of this it was not surprising that they were not enthusiastic in their reactions to proposals of removal to other territories. Tenants and squatters were somewhat more favorable to moving than those who were the nominal owners of the small farms. All in all, the data emphasized the need for a considerable educational program, if these people are to be willing to forsake their homes in this area for new homes in another, no matter how promising the new region may be.

Careful study of the economic situation brought out a number of important points. It showed the great extent to which the entire population—including the agricultural portion—had been directly dependent upon the lumber industry. It called attention to the very meager incomes received by the families in return for their efforts. And it aroused serious forebodings of the crisis facing the people in the area as soon as the remaining sawmills "cut out," which will be in the very near future.

The relief situation in the Ward has been, and remains, acute. Indeed a very considerable portion of the frugal incomes, referred to in the preceding paragraph, came from relief sources. Fully one-half of the farm families have been on the relief rolls. During January, 1934, the first month of our survey, 67 of 210 white families resident on farms, and 17 of the 41 white families residing in the woodland clearings, received relief. They obtained about $16 each during this month. In addition many others received advances termed "Oat Loans" from the Federal Emergency Relief Administration.

Despite the fact that they were aided by relief agencies, some families—even farm families—made no pretense of planting a garden. In this connection it is enlightening to quote some of the general impressions recorded by Mrs. Fry, who supervised the field work directly, after a three months' residence in the Parish:

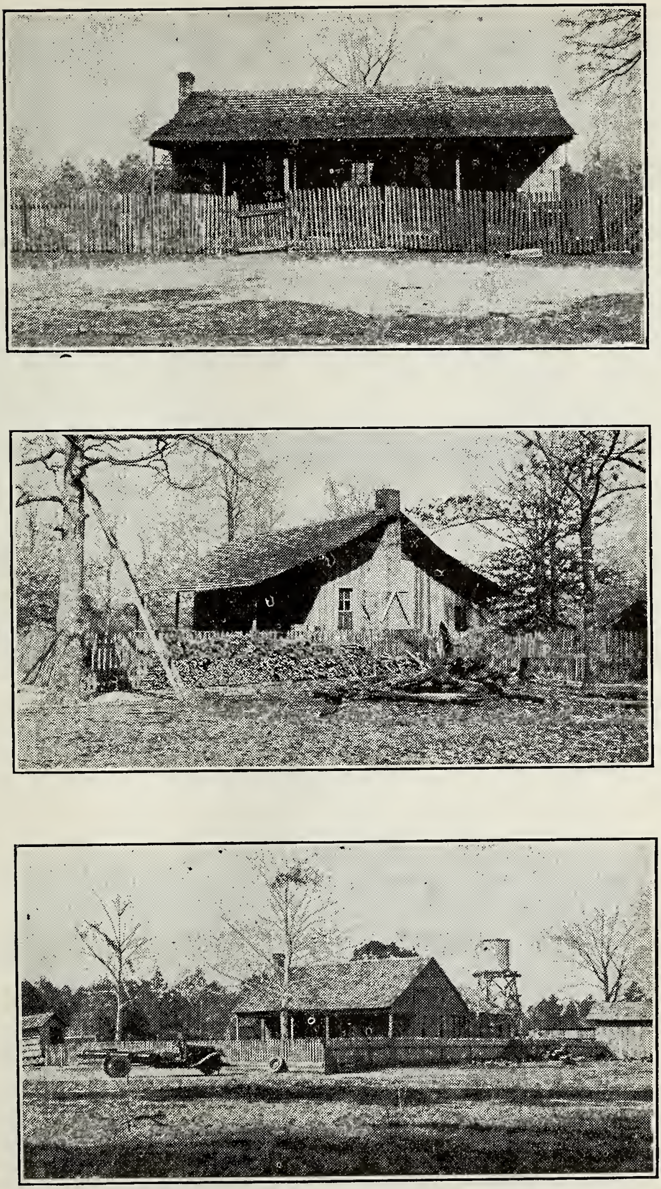

FIGURE 7.—Photographs of three of the best homes in the Open Country portions of Ward Three, LaSalle Parish. Note how the shingles protrude in (a) and (b). Leaving shingles in this manner is very prevalent in the hilly sections of Louisiana.

A general shiftless attitude is characteristic of the majority of the families. Those who are living in villages have become accustomed to working under the supervision of others. They prefer to be told what to do and how to do it, shrinking from responsibility and from the use of their own initiative. Among those who expressed a willingness to move from LaSalle Parish there was a general expression of unwillingness to attempt farming. Some even said, "I can do most anything but farm, and I intend to keep away from that as long as I can make out." As a rule persons now engaged in agriculture appear not to be making an effort to combat the difficulties under which they farm. While it is true that their farming land is poor, plots being too small in many cases, and drainage frequently inadequate, there are many improvements which might be made in the general conditions of their holdings. Fences are not kept up; gardens are not fenced; houses are not repaired. If other farm buildings are not entirely lacking, they are usually falling in decay.

During the last 10 to 20 years both people and the farming conditions and equipment show evidences of deterioration. That better days have been known is not to be denied. Furniture and rugs of maximum quality and also pictures expressing an appreciation are to be found in a somewhat dilapidated state. The inhabitants have in many cases almost given up hope. So firmly do they believe that it is impossible to make a living in LaSalle Parish, to pay one's debts, and to be an aggressive people, that they have ceased to help themselves in the small ways which would require only a minimum of cash outlay.

On the whole, farmers are opposed to stock laws. They believe that the livestock which they lose each year does not amount to as much as the taxes which they would be assessed, were it possible to check on the actual number of livestock owned.[1] Some time ago cholera was prevalent among hogs in the Parish. Soon it became the opinion of many farmers that there was no use to try to raise them. It was almost as though an excuse for neglecting hog-raising was welcome. Apparently a great many more chickens could be raised than are actually being produced.

If a garden was destroyed by drought last year, or if a storm or high water caused it to yield only a small portion of the expected produce, this is likely to be considered a justification for planting no garden this year. One feels the suggestion of fatalism among the population. Most of the families residing in the open country plant gardens, but the idea of preserving food, either by drying or canning, seems unimportant to them. Vegetables they regard as food to be eaten fresh and in season. The fact that they may have lost a few cans of food in years past is sufficient reason for giving up the hope of preserving food for winter use. Canning, however, while it would be very helpful to the farmers, if more extensively developed, is not the only means whereby more food might be provided at home. With the long growing season in this part of the country it is possible to produce something fresh and green practically every month in the year. Here one wonders what effect the canning projects of the Federal Emergency Relief Administration has had. Their canning demonstrations to farm women deserve much credit as do efforts to instill thrift into the rural people, but so long as farmers know that a commodity warehouse located in the parish seat is heavily stocked with canned vegetables and meat and that only the showing of an empty larder and pleas for food are required in order to obtain direct relief orders from this storehouse, their initiative may be definitely curtailed. In other words, they seem to like relief and to be out for their share of "what the government owes them."

Perhaps dependency upon a relief agency has had much to do with the failure of farm operators to preserve their places and equipment to the best of their ability. To look prosperous in any degree may endanger one's chances of obtaining aid even though that aid is not now solicited but might be called for later. In the sawmill villages of Trout and Good Pine, provision is made for

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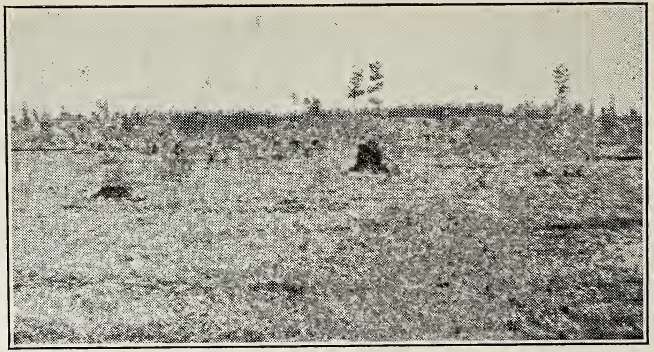
[1] One of the more prosperous women was not at all hesitant in telling the interviewer that she had 40 cows and was paying taxes on only eight of them.

Here are a few of the stately pines which once covered the upland portions of Northern and Central Louisiana.



This is how the landscape looks after the trees have been removed.

A two-room school, representative of the institutional life of the area (note the wagon in which the children are transported to and from school).

each of the families to have access to individual garden plots of approximately one-fourth acre. It has been found that, especially among families on relief, these gardens are either not being planted or are given so little attention as to be almost totally unproductive.

Finally it appears that the system of farming practiced in the area is a very unfortunate one. Farms are small, the cultivated areas slight, and much too great dependence placed upon the very limited acreages of cotton. Livestock is scarce in the area. The nature of the territory would seem to call for extensive rather than intensive methods of cultivation. It is entirely possible that a fairly successful system of farming might be developed in the better part of the area if the farming operations were on a more extensive scale, with livestock one major enterprise, food and feed crops a second, and timber products a third. Cotton might be retained in a place of secondary importance, and orchard fruits might be found to produce well in the region. Of course, if any large areas are actually retired from agricultural uses and returned to forests, this area should be one of the first to go.

In conclusion, let us mention that our investigators failed to discover wholesale evidences of biological deterioration of the stock such as one encounters on every hand in some backward localities. It is true that long-continued struggle against overwhelming obstacles seems to have broken the spirit and sapped the initiative of a considerable portion of the population. This has occurred to such an extent that large numbers of people have almost ceased attempting to do for themselves. In this connection it is important to call attention to the heavy cost to this and similar areas, resulting from the lack of fructifying contacts with other peoples and cultures. To meet the crises which arose when the game was exhausted, the forests destroyed, and the soil depleted, these people have been almost wholly dependent upon their own inventiveness. This has been a great disadvantage, for a community left to itself never makes much progress. Practically everything a given individual or group does or knows is borrowed from somebody else. Isolation seems to be one of the greatest handicaps under which these people have labored.

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The Effect of the Plane of Nutrition of Ewes upon Their Wool, Lamb, and Milk Production

By

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AND
AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATIONS
C. T. Dowell, *Director*

The Effect of the Plane of Nutrition of Ewes upon Their Wool, Lamb, and Milk Production

By M. G. SNELL
Louisiana Agricultural Experiment Station

SUMMARY

One of the problems of the wool grower on the cutover areas of Louisiana is the loss of wool during the winter. Examination of large numbers of sheep in the eastern area by a representative of the Bureau of Animal Industry showed this condition not to be due to scab.

The Louisiana Agricultural Experiment Station, in an attempt to solve this problem, conducted a three-year experiment consisting of four lots of 10 ewes each fed in dry lot. Lot I was full fed, lot II full fed eight months, and one-third full fed for four months, lot III two-thirds full fed, and lot IV one-third full fed. Data on live weight, wool production, lambing, and milk production were secured on the ewes; birth and 120-day weights and measurements were secured on the lambs. The conclusions drawn from these data are summarized as follows:

Ewes on a high plane of nutrition produce more lambs, are better mothers, and are better producers of wool than ewes on a low plane of nutrition.

Ewes full fed eight months and then fed on a very low plane of nutrition for about four months produce fewer lambs, less milk, lambs weighing less at the end of 120 days, and less wool than do ewes fed a good ration the year round.

Ewes fed an extremely poor ration are poor mothers, poor milkers, poor breeders, have light lambs at weaning time, and shear light fleeces.

A low plane of nutrition may result in the shedding of wool.

A low plane of nutrition fed to the mother reduces the weight of the lamb at 120 days, but does not have any consistent effect upon the lamb's wool up to 120 days.

A low plane of nutrition, such as was fed in this experiment, does not increase the ability of the ewe to digest feed.

The practical lesson to be drawn from these data is that year-round care and attention will result in (1) thriftier ewes that are heavier milkers and better mothers; (2) an increased number of lambs being born; (3) a larger percentage of lambs being raised; (4) larger lambs at weaning time; and (5) heavier fleeces.

INTRODUCTION

The shedding of wool by sheep is one of the problems of the wool growers of the cutover lands throughout their lifetime. They have no shelter other than that afforded by nature, are not fed during the winter, and receive little attention other than branding, marking, and shearing.

Sheep handled under these conditions may come through the winter in good condition, raise a good crop of lambs, and shear heavy fleeces of wool, but frequently large numbers of grown sheep are lost, the wool clip is light, and few lambs are raised. In addition, many of the sheep may shed their fleeces either partially or entirely.

Wool sheeding seems most widespread after wet winter and spring months. Sheep will start losing wool in small patches and may continue to lose it until most or all of the fleece has been shed.

REVIEW OF LITERATURE

As early as 1848, Youatt (1848) states that both climate and feed affect diameter, length, and amount of wool produced by sheep. Recent writers have expressed these same views.

Masterdon (1926), in an article on wool growing in New Zealand, states that the appearance of the wool can be altered in a very short time by the different types of soils. According to him, both the crimp and yolk will be altered; light soils produce finer and lighter fleeces; strong, heavy clay soils will produce wool with little crimp and a lack of character; limestone soils will grow strong wool with a hard feel.

Roux (1926), of South Africa, while studying at one of the larger universities of the United States, wrote that climate and soil conditions are the most important factors controlling the production of good quality wool, the best quality wool being grown in a country suitable for short, sweet grass. Colder countries tend to produce dense, finer fleeces with more yolk; arid conditions, longer wool with less density, coarser, and with a tendency toward harshness.

Another idea (Anonymous, 1922) concerning the effect of feed on wool production is contained in a popular article in a London, England, livestock journal. According to this writer, the growth of wool will not be affected so long as the liveweight of the animal is maintained. Liberal feeding may give a heavier fleece, but the difference was thought to be due to an increased deposition of wool fat rather than to an increase in wool fiber.

Experimental evidence tends to sustain these popular views.

Cook and Jones (1891) noted that the diameter of wool fiber produced by a ewe during sickness was smaller than that produced during normal health. Wilson (1934, 1935) found that a purebred Lincoln ewe produced wool during a four months' sick spell at a reduction of 42 per cent in the rate of growth, in length, and in diameter, showing that sickness reduces both the length and diameter of the wool fiber grown, as well as the total amount of wool grown.

Craig (1896) reported the effect upon their wool production of three methods of feeding lambs to approximately 10 months of age. The lot I lambs were grain fed from birth to market age, lot II from weaning to market age, and lot III for a two months' fattening period. The grease weights of wool were 8.7 pounds, 7.5 pounds, and 7.5 pounds, respectively. The shrinkage percentages were 43.0 per cent, 37.1 per cent, and 38.0, respectively. The yields of clean wool were 4.9 pounds, 4.7 pounds, and 4.5 pounds. The lambs getting grain for the longest period of time produced the heaviest fleeces with the greatest shrinkage, but with the greatest amount of wool fiber. These figures indicate that feed affects both the growth of wool fiber and the percentage yield or shrinkage.

Russel (1913) reports three years of work at the Wisconsin station in which rations high and low in sulphur were fed to sheep. No effect was noted upon the gross weight, the shrinkage, or the clean wool content of the fleeces.

Hammond (1916) found that April-shorn sheep produce more clean wool but less grease wool than sheep shorn in June.

Zuntz (1920) kept sheep at a constant weight on a ration of straw and beets. One group of two animals received daily from 8 to 10 grams of digestible horn in addition. After four months, the fleeces of the group receiving horn showed more strength (development) than that of the other group. Microscopic examination showed the wool fibers to have increased about one-third in diameter and each single fiber had strengthened itself.

Hill (1921) found that a group of 60 wethers sheared 4.09±.07 pounds each of clean wool when taken off a Wyoming range. For the following three years when fed under dry lot conditions they averaged 5.19±.08 each. He concludes from these data that range sheep do not ordinarily get enough feed to bring out fully inherent capacity for the production of wool.

Henry and Morrison (1922) state that Wilson and Kuhlman at the South Dakota station increased the wool yield of lambs 9 per cent by adding linseed meal to a ration of corn, oats, and prairie hay.

Hammond (1922) found that ewes wintered on a daily ration containing 0.63 pound of corn and 0.12 pound of linseed meal plus hay and silage average 7.87 pounds of wool. A similar group of ewes wintered on a similar ration, except that they received 0.4 pound of corn and 0.35 pound of linseed meal daily, sheared 8.23 pounds of wool. Here the replacement of 0.23 pound corn with a similar amount of linseed meal increased the average yield of wool by 0.96 pound.

Lush and Jones (1923) found that the individuality, age, and sex affected the fleece weights of fine wool sheep run under range conditions.

Evvard and Culbertson (1924) fed ewes on rations containing the following amounts of salt daily: none, one-fourth ounce, one-half ounce, and one ounce. The average fleece weights per ewe were 7.03 pounds, 8.04 pounds, 8.52 pounds, and 7.65 pounds, respectively.

Joseph (1927), from wool studies with fine wool sheep under varying conditions, concludes (a) that the wool fiber is not easily affected by a change in the level of feeding for a period of five or six months; (b) that quality of the wool fiber is not affected at all; (c) that the quantity of wool fiber may be modified only slightly as long as the sheep remain in normal health; and (d) that the age of the wethers affects the diameter of the wool fiber only slightly, but after from three to four years causes a decrease in length of wool fiber.

Spencer, Hardy, and Brandon (1928) state (1) that age affected the length of wool fiber in that as the age of the ewe increased the length of wool fiber decreased, and (2) that fleeces from ewes three years of age averaged heaviest and those over five years of age lightest. Heavy shrinkage was associated with the shorter fleeces. The longer fleeces were heavier, had less grease and dirt (shrinkage), but were a little less dense.

Hardy and Tennyson (1930) found that the rate of growth of wool and the fineness of fibers produced varied throughout the year, both the rate of growth and the diameter of fiber being greatest in fall and least in midwinter. The period of most rapid growth was associated with the largest diameter of wool fiber, while the period of greatest wool growth was associated with the period of general thrifty condition, as indicated by its weight. The period of least wool growth was associated with lambing time and the 45 days preceding. This experiment shows a rather close association between the thriftiness of the sheep and the quantity and quality of wool produced.

Wilson (1931) fed three Romney wethers on a fattening ration for six months. This was followed by a maintenance period of six months and then by a six months' feeding period in which the wethers were on a submaintenance ration. The wools grown during the first and third periods were compared. The first six months' period produced about three times as much grease and clean wools as the third period. Furthermore, the wool was larger in diameter, about twice as strong, almost twice as long, was loftier, and had a superior crimp to that produced during the third or submaintenance period.

Weber (1931) fed sheep on a low plane of nutrition followed by full feed. When on full feed the sheep produced 100 per cent more scoured wool than when on a low plane of nutrition, and the fibers were 15 per cent larger in diameter and 14 per cent longer.

Marston (1932) found the feeding of 100 lambs with blood meal containing 2.7 per cent cystine increased the wool yield over 35 per cent. About 40 per cent of the ingested cystine was recovered in the fleece.

Hill (1912) reported on the use of the fiber-testing machine for measuring the strength and elasticity of wool. Hardy (1918, 1920) found both temperature and humidity affected the elasticity and strength of wool fibers.

Burns and Koehler (1925) and Burns (1935) found the micrometer caliper satisfactory for the measurement of diameter of wool fibers.

SHEDDING IN LOUISIANA

In the spring of 1930, groups of sheep were counted at numerous places on the range and the number of shedding sheep noted. On the average, 6 out of every 25 grown sheep had shed their fleeces either partially or completely. In some cases, only a small patch of wool would be missing; in others, the sheep had shed practically its entire fleece.

SHEDDING NOT DUE TO SCAB

In some cases the sheep would seem irritable, rub or gnaw itself, and show other symptoms of scab infection. A representative of the Bureau of Animal In-

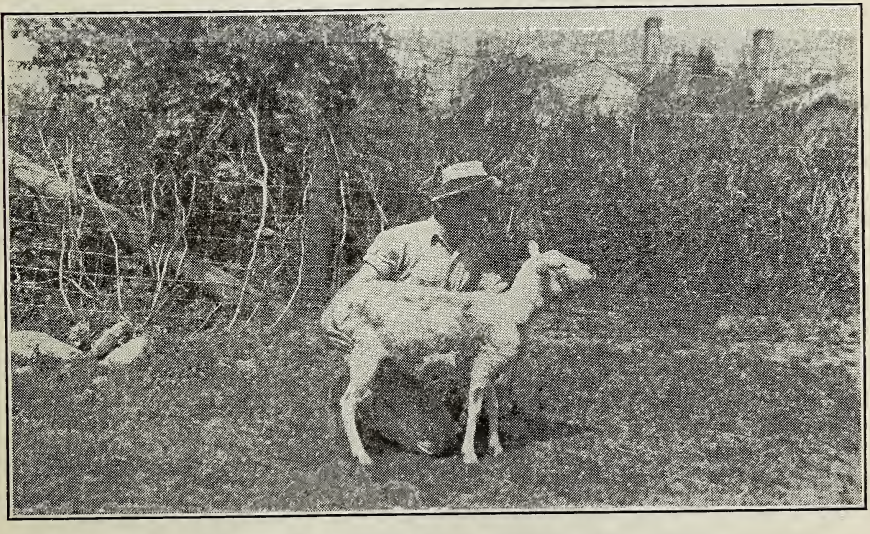

FIGURE 1.—Poor feeding produces shedding. This ewe shed practically her entire fleece.

dustry was called in and approximately 20,000 sheep were examined. Scab was not found; hence, feed and range conditions seemed to offer the most likely solution to the problem.

EXPERIMENTAL PROCEDURE

The life of a ewe on the cutover range falls into about three definite periods. Beginning in June the ewe is shorn. From then to October, the chances are that she has good grazing, suckles her lamb, and has a fairly easy time. From October to February or March the grass is dried up and grazing is short. The ewes get thin and the mortality rate may be high. In February the grass starts coming out and with the spring months there comes a new crop of lambs. Hence, the year may be divided into (1) February to June, lambing and lamb nursing months, (2) June to October, largely months of good grazing, and (3) October to February, the winter period.

In an attempt to duplicate these range conditions and at the same time to get information on the effect of feed upon wool, milk, and lamb production, the Louisiana Agricultural Experiment Station started an experiment as follows: In June, 1931, 40 head of grade Cheviot ewes were divided into four lots of 10 head each. The lot I ewes were given all the feed they would consume; the lot II ewes were fed the same as the lot I ewes for eight months, but for four months, representing the winter feeding period, they received only one-third as much as the lot I ewes. The lot III ewes were fed two-thirds as much as the lot I ewes, while the lot IV ewes were fed only one-third as much as those in lot I. This feeding plan was followed for three years, with one exception. During the winter months (October 1 to February 1) of 1932, the lot II ewes were fed the same as the lot I ewes, but received only one-third of a full feed during the suckling period, February 1 to June 1.

The ration fed consisted of 60 parts hay and 40 parts grain. Accurate records on feed consumption were kept throughout the three years. The ewes were weighed regularly every 28 days. Birth and 120-day weights and measurements were obtained on the lambs. Individual wool samples were taken from each ewe at the end of each

TABLE I. AVERAGE DAILY FEED CONSUMPTION BY PERIODS

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	2.583	2.583	1.722	0.861
2	3.719	1.240	2.480	1.240
3	3.750	3.750	2.500	1.250
	1932-1933			
1	3.326	3.305	2.283	1.143
2	3.000	3.000	2.000	1.000
3	3.000	1.000	2.000	1.000
	1933-1934			
1	3.183	3.183	2.122	1.061
2	2.592	0.862	1.725	0.862
3	2.454	2.448	1.636	0.818

The average weights by lots, periods, and years are shown in table II.

period, namely, June 1, October 1, and February 1. Wool lengths, diameter, and crimp of fiber were determined from these individual small samples, micrometer calipers being used to determine the diameter of wool fibers. Wool weights were secured at shearing time. Shrinkages and scoured fleece weights were determined from samples secured at this time.

The average daily ration fed each ewe in each lot for each period is shown in table I.

TABLE II. AVERAGE WEIGHTS OF EWES BY LOTS, PERIODS, AND YEARS

Period	Lot I	Lot II	Lot III	Lot IV
Initial weight	68.4	70.0	68.4	70.4
	1931-1932			
1	83.6	83.2	73.2	53.8
2	106.8	70.0	80.1	61.3
3	112.0	92.6	81.1	51.8
Average	100.8	81.9	78.1	55.6
	1932-1933			
1	120.6	104.8	77.0	56.9
2	134.4	119.9	85.0	56.6
3	113.3	82.4	71.2	67.5
Average	122.8	102.4	77.7	60.3
	1933-1934			
1	115.4	106.2	83.6	68.7
2	123.1	77.3	72.0	54.4
3	96.5	94.0	65.5	60.5
Average	111.7	92.5	73.7	61.2
	AVERAGES			
1	107.3	98.1	77.9	59.8
2	121.4	89.1	79.0	57.4
3	107.3	89.7	72.6	59.9
Average	112.0	92.3	76.5	59.0

ANALYSIS OF VARIANCE

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	Snedecor's F Value— Obtained	Snedecor's F Value— Significant Value
Total	359	2,793.4	-----------	--------	------
Within	324	1,008.9	3.114	--------	------
Between years	2	83.79	41.895	13.43	3.03
Between lots within years	9	1,416.51	157.390	50.54	1.97
Between periods within year and lot	29	284.22	11.842	3.80	1.55

This table shows the ewes in all lots at the beginning of the experiment to weigh approximately 70 pounds, but at the end of the first year, the lot I ewes had gained approximately 30 pounds, while the lot IV ewes had lost about 14 pounds. The average weight for the three years shows the lot I ewes to weigh almost double the lot IV ewes.

The average weights by periods show the lot I ewes to be heaviest during the winter months when pregnant. The lot II ewes varied in weight according to the amount of feed fed, while the lot III and lot IV animals tended to maintain a more or less uniform weight.

The lot I ewes were able to increase their weight in order to take care of the growing foetus. Lots III and IV remained more or less constant in weight throughout the year, which indicated that possibly these ewes were growing their foetuses in part, at least, at the expense of their own body tissues.

The average fleece weight, yield percentages, average scoured weights, and average length of the fleeces are shown in table III.

TABLE III. GREASE WEIGHTS, YIELD PERCENTAGES, AND SCOURED WEIGHT OF THE FLEECES

Lot	Year	Grease Wgt. lbs.	Yield %	Scoured Wgt. lbs.	Staple Length cm.
I	1	5.26	61.21	3.20	10.92
	2	6.05	68.22	4.18	12.70
	3	3.90	71.19	2.76	9.49
	Average	5.07—	67.07	3.38	11.04
II	1	3.63	62.65	2.34	9.88
	2	3.68	63.45	2.30	10.05
	3	2.10	67.42	1.35	8.43
	Average	3.14	64.54	2.00	9.45
III	1	2.64	61.98	1.63	9.18
	2	2.95	67.37	1.93	9.15
	3	0.99	60.10	0.67	9.22
	Average	2.19	63.15	1.41	9.18
IV	1	0.90	63.17	0.58	7.14
	2	1.47	63.19	1.68	8.83
	3	1.30	65.17	0.85	5.75
	Average	1.22	63.84	1.04	7.24
Significant differences between periods		0.46	0.95	0.094	0.485

This table shows the amount of feed fed to have a marked effect upon the grease weight, scoured weight, and staple length of wool produced by the ewes. Contrary to the opinion sometimes expressed, an increase in feed did not cause an increase in the shrinkage of the wool, owing to an increased grease content of the fleece. Rather, the lot I ewes had less grease and dirt and more actual wool in their fleeces than did the ewes in the other lots. The length figures indicate that the lot I ewes grew more wool than did the ewes in the other lots, and that the lot IV ewes produced the least. This table shows clearly that well-fed ewes produce heavier fleeces, with less shrinkage but more length, than do ewes that are on poor rations.

One further comment should be made concerning this table. Lots II, III, and IV showed a tendency to shed. The low feeding period to which the lot II ewes

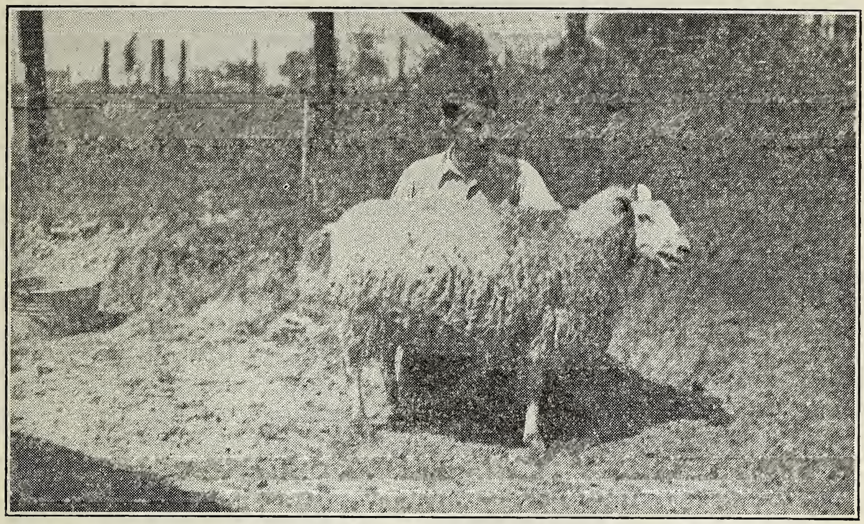

FIGURE 2.—A lot I ewe. Good feeding produces health, vigorous mothers, heavy fleeces, and strong lambs. These ewes averaged 112 pounds.

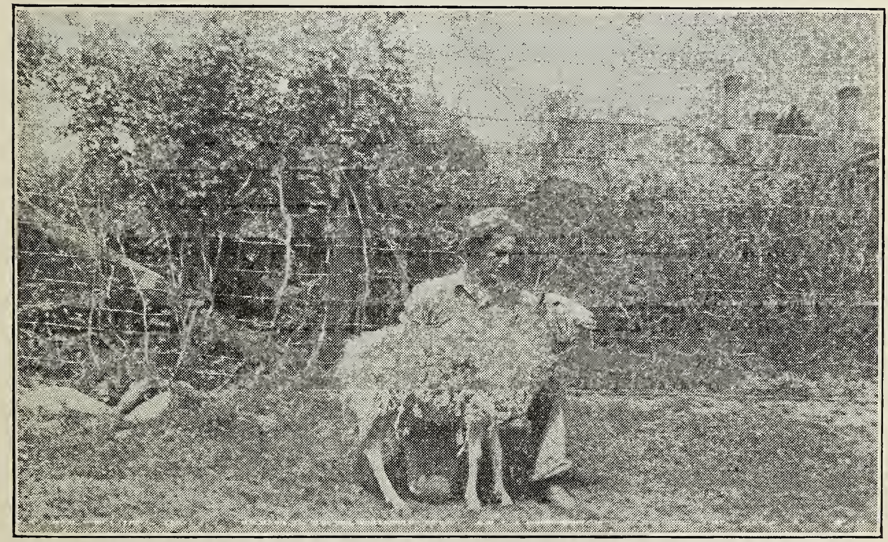

FIGURE 3.—A lot II ewe. Poor winter feed reduces the average yearly weight, the wool crop, the milk supply, and the number of lambs produced. These ewes averaged 92 pounds.

were subjected apparently weakened the fiber and caused some of the ewes to lose wool. In order to minimize this loss, the ewes in these three lots were kept in canvas covers. However, in spite of these precautions, two ewes in lot IV shed almost their entire fleeces. This tendency to shed reduces the value of the average fleece weight figures, but does seem to answer one object of this experiment, namely, that lack of feed may result in wool shedding.

From the small samples of wool secured at the end of each four-month period, data on length, diameter of fiber, and crimp per inch were secured. The average length of wool grown by the ewes in each lot is shown by periods in table IV.

TABLE IV. EFFECT OF AMOUNT OF FEED FED EWES UPON THEIR GROWTH OF WOOL IN LENGTH

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	4.05	4.27	3.46	2.97
2	4.24	3.30	3.66	2.78
3	4.12	3.45	3.57	2.78
Average	4.14	3.67	3.56	2.84
	1932-1933			
1	4.22	3.86	3.61	3.12
2	4.66	4.14	3.59	3.00
3	4.34	3.95	3.33	2.75
Average	4.41	3.98	3.51	2.96
	1933-1934			
1	4.37	4.18	4.08	3.51
2	4.60	3.54	3.63	3.11
3	3.98	3.24	2.90	3.11
Average	4.32	3.65	3.53	3.22
	AVERAGE			
1	4.21	4.10	3.72	3.20
2	4.50	3.66	3.63	2.96
3	4.15	3.55	3.27	2.88
Average	4.28	3.77	3.54	3.01

ANALYSIS OF VARIANCE*

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value Obtained	Significant Value
Total	359	.017945	-----------	-------	-------
Within	324	.010625	.003279	-------	-------
Between years	2	.00020	.000100	32.79	19.50
Between lots within years	9	.00599	.000665	4.93	2.71
Between periods within year and lot	24	.00163	.000679	4.83	1.73

*Coded figures; original numbers divided by 120.

The rate of growth of wool fiber was greatest with lot I ewes and least with the lot IV ewes. In the lot I ewes, the months of greatest wool growth were October, November, December, and January. In all other lots the period of greatest wool growth was from June to October. This indicates so far as the well-fed lot I ewes were concerned that late fall and winter were more ideal for wool growth than either spring or summer. The chances are that these ewes received enough feed to make their maximum growth during the fall and winter and were not annoyed as much by the heat, flies, insects, etc., as in the other two periods. Nor was pregnancy as much of a strain as was the giving birth to and nursing of lambs during the following period.

The ewes of lots II, III, and IV produced wool at their maximum rate during the summer months following shearing, indicating that pregnancy and lactation from October 1 to June 1 probably affected wool growth more than the heat and annoying insects of the summer months. In all cases, the periods of least wool growth were from February 1 to June 1, showing that lactation is a more severe drain upon a ewe, as indicated by wool growth, than is pregnancy.

Summarized, table IV indicates that (1) the period most favorable for wool growth is from October 1 to February 1, provided the ewe has all the feed she cares to eat; (2) when an adequate amount of feed is not available, the summer months are most favorable for wool production; (3) the spring months corresponding with the lactation period are the months of least wool growth; i.e., lactation is a greater drain upon the body of the ewe than is pregnancy, in so far as is indicated by wool growth.

The average diameter of wool fibers is shown in table V.

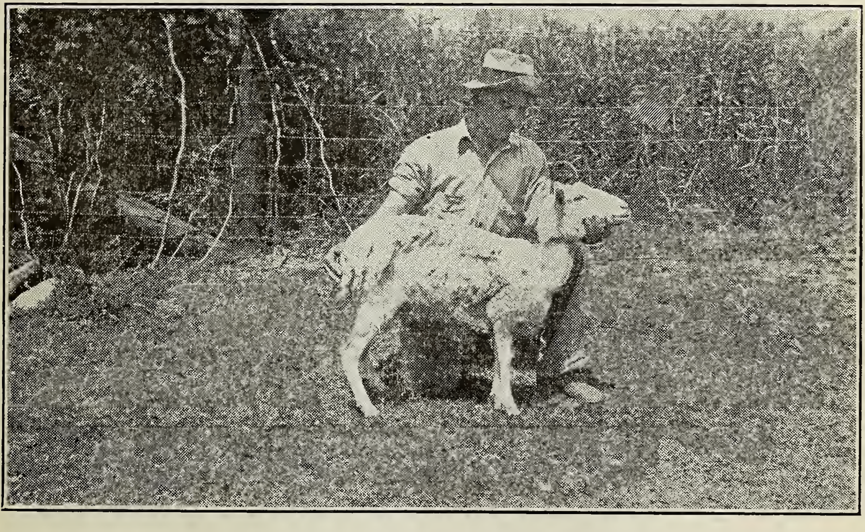

Figure 4.—A lot III ewe. Two-thirds of a feed is not enough to insure regular breeding, heavy fleeces, and good milk flow. This ewe lost most of her fleece. These ewes averaged 77 pounds in weight.

TABLE V. EFFECT OF AMOUNT OF FEED CONSUMED ON DIAMETER OF WOOL FIBER

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	10.358	10.27	9.52	9.50
2	9.92	8.50	9.41	7.58
3	9.35	8.72	8.39	6.61
Average	9.874	9.16	9.11	7.89
	1932-1933			
1	10.37	10.44	10.06	8.28
2	10.64	11.36	10.14	7.84
3	10.98	9.58	9.17	7.71
Average	10.66	10.46	9.79	7.94
	1933-1934			
1	11.27	10.47	9.97	8.65
2	11.03	10.29	9.54	7.36
3	10.22	9.29	8.01	7.73
Average	10.84	10.01	9.17	7.91
	Averages for Three Years			
1	11.33	10.39	9.85	8.81
2	10.53	10.05	9.69	7.59
3	10.18	9.19	8.52	7.35
Average	10.68	9.88	9.35	7.92

Analysis of Variance

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value— Obtained	Significant Value
Total	359	731.19	------------	--------	------
Within	324	121.881	0.3762	--------	------
Between years	2	38.995	19.4975	51.82	3.03
Between lots within years	9	413.870	45.9855	122.24	1.97
Between periods within year and lot	24	156.444	6.5185	17.32	1.55

The table shows that ewes receiving a full feed produce wool with larger diameter of wool fiber than ewes receiving a smaller amount of feed. The diameter of wool fiber parallels rather closely the amount of feed fed. Likewise, the wool produced from June 1 to October 1, after the lambs are weaned, with two exceptions, averages larger than the two periods following. These two exceptions are in lots I and II for the year 1932-1933. These lots were on full feed during both periods 1 and 2. Hence, it would seem that these ewes had less demand upon their bodies during the summer and early fall months than at any other period of the year. This lessened demand upon the body is reflected in increased weights, increased length of wool, and larger diameter of wool fibers.

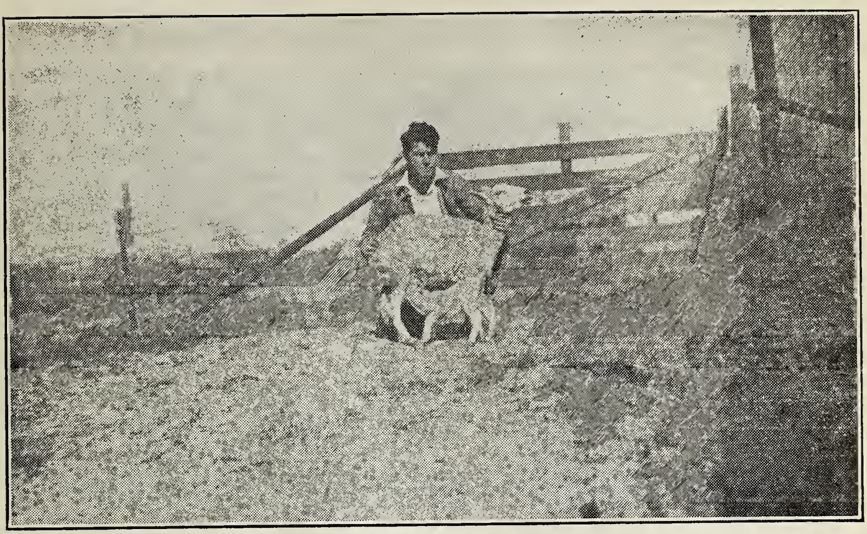

Figure 5.—A lot IV ewe and her lamb. One-third of a feed was not enough to maintain life over a three-year period. All the original ewes in this lot died. They were poor mothers, irregular breeders, and sheared light fleeces. These ewes averaged 59 pounds.

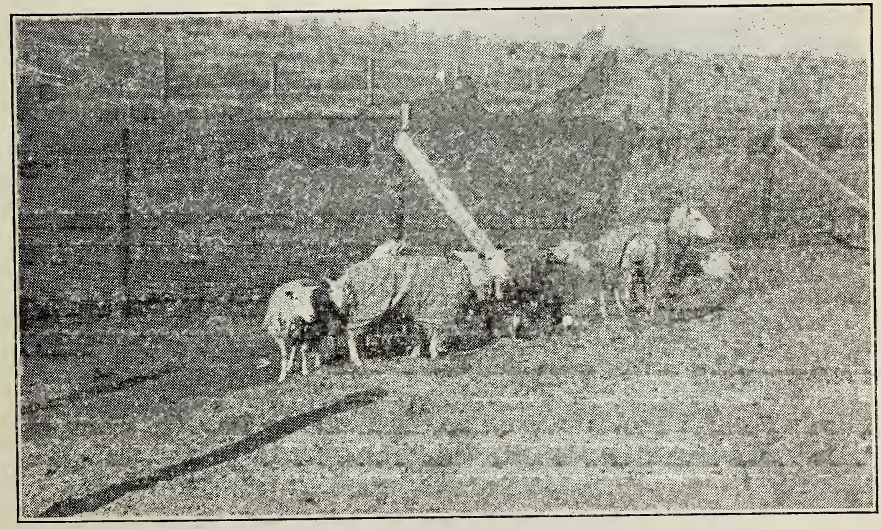

Figure 6.—The ewes in lots II, III, and IV were covered practically throughout the experiment in order to prevent the ewes pulling each other's wool.

The effect of the amount of feed fed upon the crimp of wool fibers is shown in table VI.

TABLE VI. EFFECT OF AMOUNT OF FEED FED UPON THE CRIMPS PER INCH OF WOOL FIBER

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	6.79	6.80	7.43	7.93
2	5.98	5.70	6.43	7.39
3	5.70	6.51	7.03	8.43
Average	6.16	6.34	6.96	7.92
	1932-1933			
1	5.74	6.04	7.38	9.00
2	4.95	5.97	7.16	8.92
3	5.53	5.24	8.41	9.80
Average	5.41	5.75	7.65	9.24
	1933-1934			
1	5.05	6.03	7.06	8.58
2	6.12	6.95	8.55	10.02
3	6.01	7.07	7.99	9.95
Average	5.73	6.68	7.83	9.52
	Averages for Three Years			
1	5.86	6.29	7.29	8.50
2	5.68	6.21	7.05	8.78
3	5.74	6.27	7.81	9.39
Average	5.76	6.26	7.38	8.89

Analysis of Variance

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value— Obtained	Significant Value
Total	359	1168.30	----------	--------	------
Within	324	481.22	1.485	--------	------
Between years	2	23.96	11.98	8.07	3.03
Between lots within year	9	580.40	64.49	43.43	1.97
Between periods within year and lot	24	82.72	3.45	2.32	1.55

Table VI, when examined with tables IV and V, shows that as the rate of growth increases, the number of crimps per inch decreases. The ewes on full feed produced longer and larger wool fibers, but with fewer crimps per inch. The ewes on a poor ration produced lighter, shorter, finer, and crimpier wool than their mates, which were receiving more feed.

The lambing data are shown in table VII.

TABLE VII. EFFECT OF FEED UPON THE PERCENTAGE OF EWES LAMBING AND OTHER LAMBING DATA

	Ewes			Lambs					
	In Lot	Lambing	Percentage Lambing	No. Born	Pct. Born Per Ewe	No. Raised	Percentage Raised	Sets of Twins	Lambs Born Dead
				Lot I					
Year 1	10	9	90.0	10	100.0	9	90.0	1	--
2	10	9	90.0	11	110.0	10	91.0	1	--
3	10	10	100.0	14	140.0	9	64.0	4	1
Total or Avg.	30	28	93.3	35	116.7	28	80.0	6	1
				Lot II					
Year 1	10	10	100.0	11	110.0	8	73.0	1	1
2	8	7	87.5	8	100.0	6	75.0	1	2
3	9	6	66.7	6	66.7	4	67.0	0	2
Total or Avg.	27	23	85.19	25	92.59	18	72.0	2	5
				Lot III					
Year 1	10	9	90.0	10	100.0	9	90.0	1	1
2	9	7	77.8	7	77.8	7	100.0	0	--
3	10	7	70.0	7	70.0	4	57.0	0	1
Total or Avg.	29	23	79.31	24	82.76	20	83.3	1	2
				Lot IV					
Year 1	10	9	90.0	9	90.0	5	56.0	0	1
2	7	4	57.1	4	57.1	3	75.0	0	1
3	7	5	71.4	5	71.43	0	0.0	0	2
Total or Avg.	24	18	75.0	18	75.0	8	44.44	0	4

Table VII shows that 93.3 per cent of the lot I ewes produced lambs, while only 75 per cent of the ewes in lot IV produced lambs. The amount of feed consumed during the year seems to have affected the lamb crop. The better the condition of the ewes, the greater the percentage to lamb. Likewise, the better the condition of the ewes, the greater the number of lambs born. Lot I had 116.7 per cent of lambs born, while lot IV had only 75 per cent. The lot I ewes had six sets of twins; lot II, two; lot III, one, and lot IV, none.

Severe underfeeding just before or during lambing as was practiced in lot II resulted in 5 out of 25, or 20 per cent, of the lambs being born dead. Such a low plane of feeding throughout the year produced 4 dead lambs out of 18, or 22.2 per cent. Hence, it seems that severe underfeeding just before lambing has almost as much detrimental effect upon the production of stillborn lambs as does severe underfeeding throughout the year.

The effect of feed upon the ability of a ewe to raise a lamb is reflected to some extent in table VII. In lot I, a total of 30 ewes (10 ewes during three years) raised 28 lambs, or 93.3 per cent. In lot IV, 24 ewes raised 8 lambs, or an average of 33.3 per cent. The lot I ewes did not raise as large a percentage of lambs as did lot III. This is due no doubt to the larger number of twin lambs born in lot III.

Table VIII shows the effect upon the birth weights and measurements and 120-day weights and measurements of the amount of feed fed to the ewes and the gains in these weights and measurements.

TABLE VIII. EFFECT OF FEED FED EWES UPON THE BIRTH AND 120-DAY WEIGHTS AND MEASUREMENTS OF THEIR LAMBS*

	BIRTH WEIGHT, AVERAGE				120-DAY WEIGHT, AVG.				GAIN, AVERAGE		
Year—	No. Born	Wt., Lbs.	Heart Girth, Ins.	Length Inches	Number	Wt., Lbs.	Heart Girth, Ins.	Length, Inches	Wt., Lbs.	Heart Girth, Ins.	Length, Inches
					LOT I						
1	8	7.0	13.6	20.4	7	42.5	28.7	37.4	36.6	16.9	17.3
2	8	7.65	13.9	20.8	8	51.0	30.5	40.5	43.4	16.5	19.8
3	9	7.1	14.1	20.5	9	33.8	26.0	35.7	26.8	12.0	14.6
Total	25				24						
Average		7.21	13.88	20.54		42.06	28.29	37.81	34.9	14.92	17.14
					LOT II						
1	6	7.1	13.9	20.0	6	45.0	29.5	37.0	37.9	15.6	17.0
2	6	6.8	13.8	20.2	6	39.3	27.2	36.5	32.6	13.4	16.3
3	6	6.2	12.8	20.4	4	37.1	27.7	38.5	30.6	14.5	15.9
Total	18				16						
Average		6.66	13.48	20.18		40.91	28.19	36.56	34.11	14.52	16.49
					LOT III						
1	9	6.9	13.8	20.2	9	44.8	26.6	36.9	37.9	12.8	16.7
2	7	7.5	14.2	20.7	7	36.9	26.2	35.9	29.4	12.0	15.2
3	8	7.1	13.6	21.1	4	36.1	27.5	35.6	28.3	13.6	14.2
Total	24				20						
Average		7.14	13.88	20.67		40.27	26.65	36.31	33.00	12.67	15.69
					LOT IV						
1	8	5.7	12.7	19.3	5	34.4	25.3	34.0	28.0	12.3	14.9
2	4	4.1	9.8	14.6	3	28.2	24.0	33.2	22.8	11.3	14.4
3	4	4.2	12.6	19.6	0						
Total	16				8						
Average		5.19	11.67	19.10		32.06	24.81	33.69	26.09	11.94	14.71
					AVERAGE						
1	31	6.63	13.49	19.96	27	42.30	27.55	36.53	35.47	14.34	16.59
2	25	6.96	13.70	20.23	24	41.10	27.60	37.27	34.06	13.79	16.91
3	28	6.25	12.99	19.76	17	35.12	26.76	35.73	28.06	13.00	14.86

*Only singly born lambs used in this table. All twins excluded.

This table shows considerable variation in weights and measurements of lambs. Because of these variations, the only figures that differ significantly are 120-day weight figures, and the figures on gain in weight. The amount of feed fed the mothers caused no significant difference in the birth weights of the lambs. At 120 days of age, the weights of the lambs did differ significantly. The lambs in lot IV were significantly lighter than lambs in the other three lots both at birth and at 120 days, in spite of the fact that the lambs in all lots were creep fed grain. The amount of milk given by the ewe might be responsible for this difference.

The average daily milk production of the ewes and the average gains of the lambs for the year 1933 are shown in table IX.

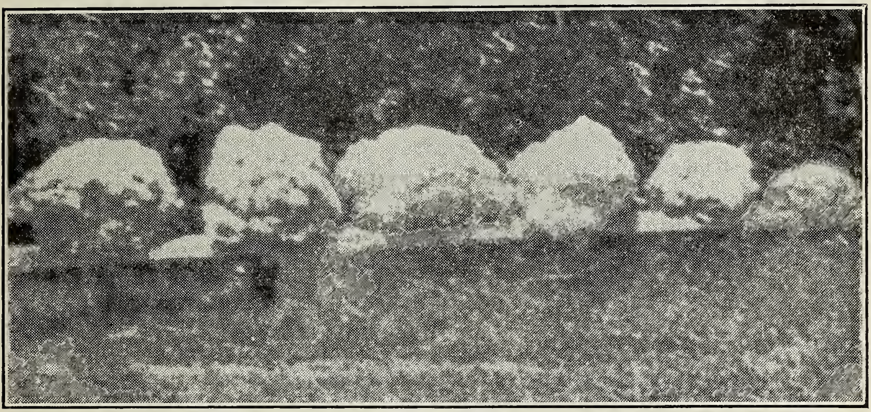

FIGURE 7.—Feed affects wool production. The lot I ewes produced 5.07 pounds of wool; lot II, 3.14 pounds; lot III, 2.19 pounds, and lot IV, 1.22 pounds.

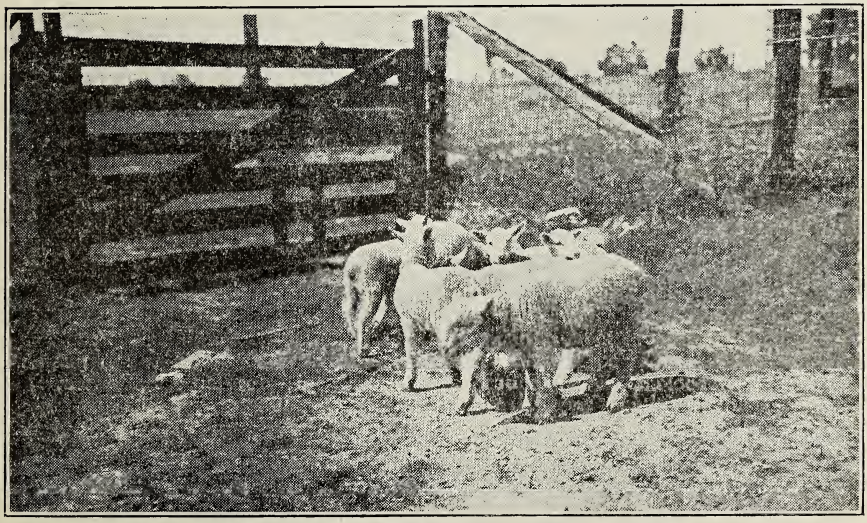

FIGURE 8.—Well fed ewes produce strong, vigorous lambs. Twenty-four lot I lambs averaged 42 pounds at 120 days of age.

TABLE IX. AVERAGE DAILY MILK PRODUCTION* TOGETHER WITH THE AVERAGE GAINS IN WEIGHT OF THEIR LAMBS. 1933

Lot	Daily Milk Production, Grams	Gain, 120-Day Wt. of Lambs, Lbs.	Remarks
I	257	45.3	Full fed
II	170	31.4	1/3 full fed
III	160	31.7	2/3 full fed
IV	76	23.0	1/3 full fed

*Average daily milk production obtained for 7-day period beginning on the 28th day after the lamb was dropped.

This table shows a rather close association between the amount of feed fed in each lot, the average daily milk production of the ewes in those lots, and average gains of the lambs from birth to 120 days.

The data secured on the 120-day wool samples of the lambs are shown in table X.

TABLE X. LENGTHS, DIAMETERS, AND CRIMPS OF LAMBS' WOOL, 120-DAY SAMPLES

Year—	Lengths, Cm.	Diameters, .0001 In.	Crimps per In.
		Lot I	
1	3.43	7.03	9.64
2	3.19	7.15	10.97
3	3.70	7.00	9.10
Average	3.42	7.06	9.96
		Lot II	
1	3.64	7.15	8.7
2	2.96	6.66	10.5
3	4.32	7.56	9.5
Average	3.60	7.10	9.42
		Lot III	
1	3.44	6.26	9.67
2	3.33	6.50	10.57
3	3.27	6.85	10.35
Average	3.38	6.43	10.00
		Lot IV	
1	3.35	5.97	10.27
2	3.70	7.81	9.1
3	------	------	--------
Average	3.50	6.76	9.77

The lambs showed quite wide variations in the length, crimp, and diameter of their wool fibers at 120 days. The ration fed their mothers had no consistent effect on the wool growth of the lambs up to 120 days, yet there were distinct and highly

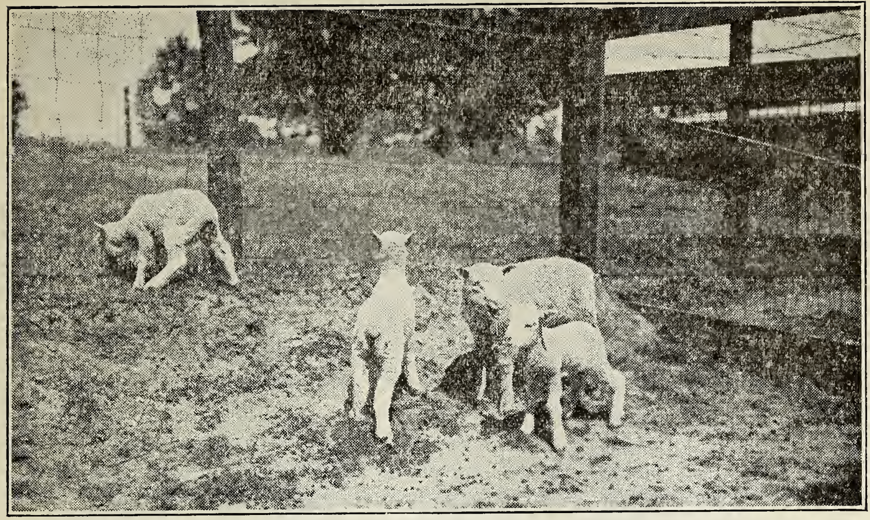

FIGURE 9.—Poor feed means few lambs and light weights. Eight lot IV lambs averaged 32 pounds at 120 days.

significant differences in their weights at 120 days. Inasmuch as a difference in the plane of nutrition of ewes caused significant differences in weight, length, diameter, and crimp of the fleeces of the ewes, it would seem logical to expect a similar difference in the fleeces of the lambs.

METABOLISM TRIALS

Three ewes from each lot were put in metabolism cages, and metabolism trials of 10 days' duration each were run.

The digestion figures obtained from these trials are shown in table XI.

TABLE XI. AVERAGE DIGESTIBILITIES OF FEED NUTRIENTS BY EWES RECEIVING DIFFERENT AMOUNTS OF FEED

LOT	RATION	PROTEIN	ETHER EXTRACT	NITROGEN-FREE EXTRACT	CRUDE FIBER
I	Full fed	62.295	77.894	78.838	58.646
II	Full fed 8 mo.				
	1/3 full fed 4 mo.	57.695	78.330	73.980	41.375
III	2/3 full fed	51.872	75.621	73.010	36.411
IV	1/3 full fed	52.144	78.598	71.652	32.399

The lot I ewes showed a higher ability to digest protein, nitrogen-free extract, and crude fiber, on the average, than did the ewes in the other lots. The lot IV ewes showed the lowest average ability of the ewes in any of the lots to digest nitrogen-free extract and crude fiber. Feeding ewes on a low plane of nutrition over a long period of time did not increase their ability to digest feed; on the contrary, they apparently lost some of their power to assimilate nutrients from their ration.

The nitrogen and ash balances are shown in table XII.

TABLE XII. TEN-DAY NITROGEN AND ASH BALANCES

	Nitrogen		Ash	
Lot	Consumed, Gms.	Balance, Gms.	Consumed, Gms.	Balance, Gms.
I	153.49	50.30	523.26	79.40
	74.43	12.20	367.23	151.75
	79.01	3.30	235.03	—120.73
Total	306.93	65.80	1125.52	110.42
Average	102.31	21.93	375.17	36.807
II	64.72	—2.08	231.24	—47.73
	75.54	7.87	180.35	—47.02
	69.36	21.03	279.48	64.95
Total	209.62	26.82	691.07	—29.80
Average	69.87	8.94	230.36	—9.93
III	129.34	16.91	462.48	—242.70
	153.41	33.14	367.20	—78.36
	125.12	24.67	501.68	94.46
Total	407.87	74.72	1331.36	—226.60
Average	135.96	24.97	443.79	—75.53
IV	64.67	14.25	231.24	—44.80
	76.70	21.33	183.60	—52.59
	69.36	13.54	279.48	1.68
Total	210.73	49.12	694.32	—95.71
Average	70.24	16.37	231.44	—31.903

The nitrogen balance figures indicate that the lot IV ewes stored a greater percentage of their nitrogen than did the ewes in any of the other lots. Whether or not this indicates a more economical use of protein is not known, yet the lot IV ewes seem to make a much more economical use of their nitrogen than do the ewes in lot III.

The lot I ewes were the only ones which showed a positive ash balance. All the other ewes were losing mineral matter from their bodies.

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JANUARY, 1936 LOUISIANA BULLETIN No. 270

Asparagus Investigations In South Louisiana

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Director

Introduction

Occasionally a venture in commerical asparagus production is tried in the far South. A few of these trials have been made in Louisiana. Judging by the growth made by the plants the first year after the crowns are set out, the projects seem very encouraging, but none has proved successful. The usual explanation for the failure of asparagus in this section is that the winters are not cold enough to insure a sufficient dormant period. The size of spears produced has been in general relatively small.

Review of Literature

Asparagus has received considerable attention from investigators in some sections of the United States, but very little emphasis has been placed on it in the South and practically none in the far South.

Jones and Robbins (3) state that in the Imperial Valley a few growers cut asparagus in the fall. It was thought possible to cut part of the crop in the spring and part in the fall, but indications were that spring cuttings were delayed on beds that had been cut in the fall. They say that the age to begin cutting asparagus beds is from two to three years, varying with the growth of the plants and the section of the country. Starting to harvest the crop the second year is practiced rather generally in the South.

Jones (2) found at Davis, California, that 18-inch spacing of crowns was best on 7½-foot rows for asparagus which was cut green.

Greene (1) reported that staminate plants were more productive than pistillate plants. This was later found to be true in California by Jones and Robbins (3) and in Massachusetts by Tiedjens (6). These investigators found that a higher percentage of large sprouts was produced by pistillate plants. On this account, Tiedjens did not believe selections of staminate plants for planting to be of practical value. Results in California indicate that staminate plants yield more profitably than pistillate plants.

Working (7) found that the branching of asparagus shoots is governed chiefly by temperature, being more rapid at higher temperatures.

Lewis (4) presents data which show that severe cutting of asparagus injured both the yield and grade of spears. The more severe the cutting, especially in the early years of the plantation, the greater the permanent injury.

Morse (5) conducted extensive studies concerning the chemical composition of the asparagus plant. He found that the reserve material stored in the asparagus roots in the autumn was principally sugars. The spring cutting of an asparagus crop considerably reduced the sugars in the storage roots.

The Problem

The work here reported was undertaken to answer the question of whether or not commercial asparagus production can be successful in the far South and, if not, to determine the reasons why.

The cutting of asparagus in the fall is practiced to some extent, and it was thought desirable to get information concerning the possibilities of fall production here. It was believed that the fall crop might prove worthwhile, even if the spring crop was not a success.

As pistillate plants have been found to produce larger shoots than staminate ones, it was thought that the use of pistillate crowns might help overcome the handicap of the production of small spears. The Mary Washington variety, which produces large spears, was used to help overcome this problem.

The age to begin cutting and the fertilizer requirements were studied.

Procedure and Methods

Seed of the Mary Washington variety was planted in the spring of 1930, and the crowns used in this experiment were grown from them during the growing season that year. In the fall many seedling plants were blooming and it was possible to select the pistillate and staminate plants needed for that phase of the work.

The crowns were set in the field in December of 1930. The soil on which they were planted was a rich Lintonia silt loam at the Louisiana Agricultural Experiment Station. The crowns were set 18 inches apart on rows 5 feet wide and 150 feet long. Ridged rows were used because they are necessary for drainage in this section of the country. The size of plots on which records were kept was 5 by 100 feet for all treatments except the fertilizer test, the other 50 feet of row being used to obtain crowns for sampling purposes. The size of plots in the fertilizer test was 5 by 50 feet. All treatments were run in triplicate except the "sex of plant" tests, which were run in duplicate. All plots except those in the fertilizer test received an application of 800 pounds of 4-12-4 per acre, which was applied in early spring, and a top-dressing of 200 pounds of nitrate of soda, applied after the cutting season was over.

The treatments given were:

1. Time of cutting test.
    Cut in the fall.
    Cut in the spring.
    Cut ½ in fall and ½ in spring.

    The first fall cutting was made after two growing seasons, and the first spring cutting was made the following year. The full fall cutting season was six weeks.

2. Effect of sex of plant.
    Staminate plants.
    Pistillate plants.
    Alternate staminate and pistillate plants.

    The first cutting was made in the spring two years after the crowns were set out.

3. Age to begin cutting.
    Cutting started in the spring one year after the plants were set out.
    Cutting started in the spring two years after the plants were set out.
    Cutting started in the spring three years after the plants were set out.

    The cutting season for plots cut one year after setting out was about four weeks. After the second year, the cutting season in the spring was about two months.

4. The various fertilizer applications used in the fertilizer test are given in table 5.

The crop was harvested as green cut asparagus. Spears were trimmed to a length of 8½ inches. Arbitrary grades were used as follows: Spears weighing 15 grams or over were called No. 1's; those weighing from 10 to 15 grams, No. 2's; and those weighing less than 10 grams, No. 3's. Yield records were obtained in grams from the weight of the spears.

Storage roots were analyzed for moisture content, reducing sugars, total sugars as invert, acid hydrolyzable material, and soluble and insoluble nitrogen. Approved methods were used. Plants for sampling were selected for uniformity of top growth. Crowns to be dug when there was no top grown were staked while top growth was present, and samples for analysis were taken by selecting representative storage roots from three carefully dug crowns. The roots were thoroughly washed and the excess moisture allowed to dry off. They were then ground in a food chopper and samples preserved in alcohol until analyses could be made. Moisture content was determined by drying about 10 grams of ground material to constant weight at 90° C.

To harvest a fall crop of asparagus the tops were cut at the surface of the ground and removed. The new shoots that were put out were harvested.

Experimental Results

The plants came up and grew splendidly the first year, attaining a height of about five feet. It was noticed, however, that a new set of shoots came up approximately every month and thus there was a continual production of shoots and new top growth during the growing season. This continual production of shoots and tops occurred every growing season and is believed to be an important factor concerning the culture of asparagus here.

Results obtained with the time of cutting test

Yields obtained from this test are shown in table 1. The harvest seasons are divided into periods, so that yields for the plots cut half in the fall and half in the spring may be compared with cutting periods of the same lengths of time for plots cut in the fall or spring only. The data show that after three weeks practically no yield was obtained in the fall, except for No. 3 spears. After the first year's results were obtained, it was thought that possibly the harvest season was started too late; so the next year the harvest was begun three weeks earlier but with similar results. Yields in the fall were very low, being almost nothing the third year harvests were made. Cutting in the fall materially reduced the yield produced by those plants in the spring.

TABLE 1. YIELDS OF ASPARAGUS IN POUNDS PER ACRE IN TIME OF CUTTING TEST

Treatment	No. 1's			No. 2's			No. 3's		
	1932*	1933	1934	1932	1933	1934	1932	1933	1934
Cut in Fall (6 weeks)									
1st 3 weeks	25.4	34.4	9.3	73.8	50.5	6.7	22.8	61.5	38.0
2nd 3 weeks	0.0	0.4	2.6	3.8	2.8	2.2	10.9	35.6	10.6
Total	25.4	34.8	11.9	77.6	53.3	8.9	33.7	97.1	48.6
Cut ½ Fall—½ Spring									
3 weeks in Fall	25.3	27.3	8.0	62.5	44.9	5.4	25.1	62.4	31.8
½ Spring season	32.4	7.9	3.7	30.2	14.7	15.6	17.9	33.5	26.0
Total	57.7	35.2	11.7	92.7	59.6	21.0	43.0	95.9	57.8
Cut in Spring									
1st half of season	111.5	45.2	34.1	43.2	28.7	40.1	17.7	23.4	38.6
2nd half of season	156.3	105.1	20.7	88.0	89.1	28.8	22.8	59.7	34.8
Total	267.8	150.3	54.8	131.2	117.8	68.9	40.5	83.1	73.4

*Spring harvest is following year in each case.

TABLE 2. ANALYSIS OF CROWNS IN THE TIME OF CUTTING TEST*

Treatment	Date of sampling	Moisture %	Reducing sugar %	Non-reducing sugars %	Acid hydrolyzable material %	Insoluble N %	N % Soluble
Cut in Spring	Aug. 31, 1933	80.20	None	6.78	1.55	0.12	0.19
Cut in Fall	Aug. 31, 1933	80.31	0.38	7.19	1.64	0.12	0.11
Cut in Spring	Oct. 6, 1933	80.66	0.12	7.78	2.13	0.15	0.15
Cut ½ Fall—½ Spring	Oct. 6, 1933	84.22	0.52	4.93	1.95	0.12	0.17
Cut in Spring	Oct. 27, 1933	78.33	Trace	8.36	2.03	0.14	0.14
Cut in Fall	Oct. 27, 1933	84.45	0.43	4.48	1.80	0.11	0.15
Cut in Spring	Jan. 19, 1934	79.46	Trace	7.54	2.05	0.23	0.29
Cut in Fall	Jan. 19, 1934	81.90	0.42	5.45	1.92	0.11	0.16

*Results given are for 1933. Quite similar results were obtained in 1932 and 1934.

In table 2 are shown analyses of crowns made in connection with the fall cutting test. The important food reserves in the crowns are non-reducing sugars. The data show that with the cutting of spears the reserve sugars are rapidly depleted. When these are reduced to between 4 and 5 per cent on a fresh weight basis, only very small spears are produced. From the time cutting was stopped in the fall until the newly put out tops were killed by cold, the plants did not build up as much reserves as did uncut plants.

Effect of sex of plant on yield obtained

Yields from this test are given in table 3. The data show that the staminate plants consistently outyielded the pistillate ones. This was true even for the larger sized shoots. The low yields in either case show that pistillate plants cannot be expected to produce good yields of large spears in the far South.

"Age to begin cutting" results

The yields obtained in this test are given in table 4. Spears were cut for a period of only four weeks on the plots that were cut the first year. Cool weather prevailed during this period and very small yields were obtained. A hard freeze killed the shoots of all plots to the ground during this period. The small cutting made the first year did not affect subsequent yields. Plots that were not cut until the third year gave slightly higher yields that year than those that had been cut previously, but all yields were very low. From 1933 to 1935 yields decreased rapidly, showing that under the conditions of the experiment there was no need to continue it.

TABLE 3. EFFECT OF SEX OF PLANT ON YIELD—YIELD IN POUNDS PER ACRE

	No. 1's			No. 2's			No. 3's		
Type of plant	**1933**	**1934**	**1935**	**1933**	**1934**	**1935**	**1933**	**1934**	**1935**
Staminate	172.7	69.0	37.5	98.8	88.9	55.7	31.7	88.5	57.7
Pistillate	95.6	58.4	14.8	71.0	50.8	29.7	31.1	46.1	34.8
Alternate Staminate and Pistillate	124.3	58.0	43.2	93.4	77.6	44.9	38.7	78.0	47.3

TABLE 4. EFFECT OF AGE WHEN CUTTING WAS STARTED ON YIELDS OF ASPARAGUS IN POUNDS PER ACRE

Age cutting	No. 1				No. 2				No. 3			
was begun	**1932**	**1933**	**1934**	**1935**	**1932**	**1933**	**1934**	**1935**	**1932**	**1933**	**1934**	**1935**
First year after setting crowns	5.8	161.3	40.2	12.9	32.8	101.5	63.0	44.9	25.0	51.5	84.2	42.8
Second year after setting crowns		151.0	34.2	11.5		98.9	63.4	39.7		41.2	85.2	47.3
Third year after setting crowns			54.2	32.8			84.1	59.3			89.2	54.5

TABLE 5. YIELD IN POUNDS PER ACRE OF ASPARAGUS FROM PLOTS RECEIVING DIFFERENT FERTILIZER TREATMENTS.

Fertilizer treatment	No. 1			No. 2			No. 3		
	1933	1934	1935	1933	1934	1935	1933	1934	1935
NP–800–4–12–0	235.4	73.6	30.6	105.6	103.8	53.3	47.8	97.2	73.5
NK–800–4–0–4	204.5	63.8	36.3	117.0	95.1	61.4	54.9	107.0	78.9
PK–800–0–12–4	237.5	76.4	44.3	132.7	78.9	59.5	46.2	101.7	63.3
NPK–800–4–12–4	287.3	89.1	49.8	106.5	107.7	59.5	39.6	94.1	66.6
Check – no fertilizer	160.2	37.5	21.5	113.2	74.5	41.8	48.3	92.2	64.4
600# 4–12–4 plus 200 $NaNO_3$T. D.	205.1	61.2	37.2	117.7	83.2	59.3	39.0	102.5	57.9
800# 4–12–4 plus 200 $NaNO_3$T. D.	169.0	42.3	15.9	118.3	64.1	23.3	49.9	83.8	59.2
1000# 4–12–4 plus 200 $NaNO_3$T. D.	147.1	51.5	16.6	79.6	72.4	46.0	46.9	87.8	56.8
1500# 4–12–4 plus 200 $NaNO_3$T. D.	134.6	47.8	25.9	121.1	69.4	44.6	53.9	83.1	60.5
800# 4–12–4 No top-dressing	205.5	58.2	34.4	98.8	60.5	55.5	47.0	89.2	58.2

Fertilizer Test

Table 5 shows the results obtained from plots receiving different fertilizer treatments. The results do not show any consistent increase from fertilizer, although in general the fertilized plots produced higher yields than the unfertilized. Yields were low in all cases and showed a steady decrease in marketable spears from 1933 to 1935. The main value of these results is to show that the application of fertilizer cannot be expected to give and maintain profitable yields under climatic conditions unsuited to asparagus production.

Analyses of Crowns from Plants Cut in the Spring

Storage roots of crowns from pistillate and staminate plants and those cut the first, second, and third years were analyzed. No consistent differences due to treatments were found, so the results, which are presented in table 6, are given as averages rather than individual treatments. These data also show that sugars are the important food reserves and are rapidly depleted by the production of spears for harvest. Apparently not enough food reserves are stored to produce a good crop of spears.

During the summer season some analyses were made of storage roots from plants from which spears had been harvested in the spring. In the spring of 1935 an analysis was made from plants which were not cut at all during the harvest season. These results are given in table 7. They indicate that during the active growing season only small amounts of reserves were accumulated. The results from the uncut sample indicate that reserves are depleted in crowns whether shoots are cut or not. The growth of tops was apparently a heavy drain on the food reserves. If this is true, it explains why the continual production of shoots during the growing season is so detrimental to the storage of reserve food in the roots.

TABLE 6. ANALYSES OF CROWNS OF SPRING CUT ASPARAGUS TAKEN DURING THE DORMANT SEASON AND AT THE END OF THE HARVEST PERIOD. FRESH WEIGHT BASIS

Date of sampling	Moisture %	Reducing sugar %	Non-reducing sugars %	Acid hydrolyzable material %	Insoluble N %	Soluble N %
January 26, 1933	78.37	0.25	9.14	1.89	0.16	0.25
April 17, 1933	81.73	0.22	5.68	1.74	0.15	0.21
January 19, 1934	79.46	Trace	7.63	1.94	0.16	0.25
May 11, 1934	84.10	0.35	4.08	1.66	0.13	0.22
January 28, 1935	77.75	Trace	8.63			
April 22, 1935	82.86	0.30	4.58			

TABLE 7. ANALYSES OF ASPARAGUS CROWNS DURING THE GROWING SEASON, AND ONE FROM UNCUT PLANTS

Treatment	Date of sampling	Moisture %	Reducing sugar %	Non-Reducing sugar %
Cut in Spring	July 9, 1934	81.90	Trace	6.06
Cut in Spring	August 9, 1934	80.25	Trace	6.92
Uncut	April 26, 1935	84.06	0.36	4.69

Discussion

The yield data which have been presented show that in the far South spring yields of asparagus may be expected to be much higher than fall yields. The spring yields obtained were low, however. Cutting for a short time in the fall seriously reduced spring yields. The production of spears of asparagus for harvest is dependent on the reserve food, mostly non-reducing sugars, stored in the roots. Analytical data presented show that the small yields of asparagus produced greatly reduced these materials in the storage roots, indicating that insufficient reserve food was stored to produce a good crop. The plants produced continual crops of new shoots during the growing season and thus, instead of storing adequate reserves to produce a good crop, dissipated their energy. During the growing season the sugar content in the storage roots varied to some extent, probably changing with production of new shoots, but not much storage of reserves occurred until late fall. At the period for fall cutting, food reserves in storage roots were lower than at the time for spring harvest to start.

The appearance of the top growth of neglected or uncut plants may easily give the impression that if plants were cared for they would produce a profitable crop. Each year there was sufficient cold in the winter for a period of dormancy. The results obtained from this experiment lead to the conclusion that the reason asparagus is not adapted to the far South is not so much lack of a winter dormant period as a lack of sufficient storage of reserve food to produce a good crop. A warm spell during winter or early spring may cause shoot growth to start, and a subsequent freeze may cause injury. This is another disadvantage in the growing of asparagus in this section. Hot weather in the fall or late spring may cause the spears to bud out very early and so interfere with the market grade. The eating quality of the asparagus produced in both spring and fall is excellent. The low yields and small size of the spears are the limiting factors of commercial production.

Conclusions

The commercial planting of even the Mary Washington variety cannot be recommended for either spring or fall production in south Louisiana. Fall harvests cannot be recommended under any condition. As asparagus is ready for harvest at a time when other locally-grown vegetables are relatively scarce, it might be grown for home use or local market to some extent. Asparagus should be grown only where weeds and grass can be controlled easily and where garden space is plentiful, as it occupies considerable space.

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Changes in the Oxidation-Reduction Equilibrium in Soils as Related to the Physical Properties of the Soil and the Growth of Rice

By
M. B. STURGIS

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Director

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CHANGES IN THE OXIDATION-REDUCTION EQUILIBRIUM IN SOILS AS RELATED TO THE PHYSICAL PROPERTIES OF THE SOIL AND THE GROWTH OF RICE*

By M. B. STURGIS

Observations made during the past five years in studies on the fertility problems of the soils of the lower Mississippi flood plain and the soils of the coastal prairies which are southwest of and adjacent to the alluvial soils show that the development of reducing conditions both from naturally poor drainage and from irrigation gives rise to peculiar difficulties. In the study of organic decomposition and nitrification in Sharkey soils which are the most extensive first bottom soils along the lower Mississippi, it was noted that the retardation and lag in the micro-biological processes following seepage from the river during the spring rises indicated that some factors which are toxic or inhibitive to bacterial action in the soil develop during poor drainage and disappear relatively slowly following drainage. Similar conditions prevail following the growing of rice which has been irrigated by methods where the soil is kept submerged from the time the rice is six inches high until the crop is almost mature. Especially has it been recognized that after rice has been grown on Crowley soils, upland crops do not usually make satisfactory growth from plantings immediately following the rice. The long continued practice of irrigation causes the development of deflocculation and other poor physical conditions in these soils and also tends apparently to permit the accumulation of reduced products which may become inhibitory or toxic to crops.

Since the effects of irrigation or water-logging on the intensity and products of reduction and their relation to the physical properties of the soil and the growth of rice have not been previously isolated or quantitatively determined, such studies are of both scientific and economic interest. The object of this investigation has been to determine the effect of water-logging and organic matter on the rate, intensity, and amount of reduction, to study the effects of irrigation on the decrease in permeability and aeration, and to ascertain the effects of certain treatments on the improvement of the physical properties and the growth of rice in Sharkey and Crowley soils.

HISTORICAL

Studies conducted by the author (50)** on the decomposition of sugarcane trash in soils of the same series as those used in this investigation have shown that when the moisture conditions and aeration of the soil are kept at optimum, the decomposition is rapid and the depression of the available nitrogen of relatively short duration.

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*Submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Iowa State College.

**Numbers in parentheses refer to "Literature Cited."

However, under intermittent high moisture conditions, the decomposition was slower and the depressive effects on the available nitrogen could not be corrected by means of additions of commercial nitrogen. The extremely low rate of nitrification in the spring following poor drainage through late winter and early spring cannot be accounted for solely through low temperature and high moisture content. There appeared to be some toxic factors which developed under wet conditions and disappeared relatively slowly when the better drainage and higher temperature prevailed. These toxic factors persisted sufficiently to materially lower the yields of corn.

Gillispie (22) found that soils became highly reducing when treated with an excess of water and that the intensity of reduction could be measured by the determination of the reducing potentials. The intensity of the reduction developed in a submerged soil is increased by the presence of decomposable organic matter. The addition of 0.1 per cent of glucose to water-logged soil caused a very pronounced reducing condition.

Clark (15) after extensive experiments supported the main features of Gillispie's work in regard to the use of the electrode in following the course and intensity of reduction in cell suspensions. He very carefully pointed to the fact that the processes of oxidation-reduction are not reversible as in many dye and inorganic systems. Poising is slow and the activity of partially cytolyzed cells induces a continuous change in the electrode potential. He found also that Eh potentials are never more positive than about 0.2 at pH 7.0, even when air has been bubbled through the cell suspensions. On the other hand, cultures of certain anaerobic bacteria cannot only induce the potential of the hydrogen electrode, which is the reference electrode having an Eh value of 0 at pH 0, but also a slight overvoltage or negative Eh value.

Cannan, Cohen, and Clark (13) have shown that the measurement of the potential differences at unattackable electrodes immersed in cell suspensions can be used to follow the progress of reducing intensities in the presence and absence of indicators. There can be found a definite potential difference between an electrode and a solution containing a mixture of oxidant and reductant. This difference is a function of the ratio of oxidant to reductant and of the pH of the solution. The characteristic potentials of a system indicate quantitatively its oxidizing or reducing relation to other systems. In contrast to solutions, cell suspensions are poorly poised with respect to the electromotively active material present at any moment but active material is slowly mobilized by cell catalysts from some large reserve. Electrodes in cell suspensions act as in solutions containing systems intermediate between those which poise well and those which have no definite effect.

In the works cited (15, 13, 54, 4) and other more common sources, the theoretical mechanisms for and the importance of oxidation-reduction reactions have been generally in agreement. Oxidation is the process in which ions, atoms or substances give up negative electrons with the liberation of definite quanties of energy. Reduction is the process in which ions, atoms or substances take on electrons. All electro-chemical changes involve oxidation and reduction. In the combination of atmospheric oxygen with substances with the liberation of energy, the molecular oxygen is reduced. During the formation of water, hydrogen atoms lose negative electrons and are oxidized while oxygen atoms receive the electrons and are reduced. Through the addition of an electron, e, there is a storage or release of a quantum of energy. The process of photosynthesis brings about the transformation of light energy into chemical energy by the reduction of carbon and hydrogen. In respiration the stored energy is changed to kinetic energy or heat by the hydrogen and carbon atoms losing electrons and becoming more positive, while the oxygen atoms receive electrons and become more negative.

The respiration processes associated with the cell tend to liberate energy so that if one atom is reduced another must be oxidized with an equal or greater liberation of energy than was required for the reduction. The significance of this fact is that normal respiration in the soil is predominantly aerobic and unless free oxygen is available during organic decomposition, the highly reactive nascent fragments of sugars and other organic substances, which have unsaturated valences, tend to combine with the oxygen of nitrates, sulphates, ferric compounds, etc., or to liberate energy through the oxidation of part of the molecule at the expense of the remainder. The amount of energy liberated in the oxidation of organic substances by oxygen that has been obtained through the reduction of other compounds is only a fraction of the amount that could have been obtained through the oxidation with free oxygen. Under very reducing conditions most of the energy liberated in the formation of carbon dioxide must be consumed in the production of highly reduced products as hydrogen, methane, butyric acid, etc. Commonly the reduced products, especially soluble sulfides and ferrous compounds, may be toxic to plants and to beneficial bacteria and, although the reduced products which have accumulated are oxidized with the evolution of energy when the soil is aerated, the energy liberated in their oxidation is probably not efficiently used in any of the more important biochemical processes of the soil.

Willis (54) and Bradfield and others (4) have found that the determination of the actual potential existing in a soil at any given time is a difficult procedure. The soil is very heterogeneous and contains many oxidants and reductants or many more or less distinct oxidation reduction systems.

It is only with reservations that the standard formulas for oxidation-reduction equilibriums could be considered as applicable to systems in the soil. However, the potentials observed in well aerated soils appear to be dominated by the inorganic ferrous-ferric iron system and, at least, the general oxidation-reduction equations might be assumed to apply for the purpose of illustration. If a platinum wire as an electrode is placed into a solution it will take on a potential which is a function of the ratio of oxidant to reductant in the solution. Reducing ions tend to give up electrons to the electrode and make it more negative as they become oxidized. Oxidizing ions tend to take electrons from the electrode and leave it more positively charged as they are reduced. The potential developed in a solution can be determined by an ordinary potentiometric set-up and, by reference to the value that would have been developed against the normal hydrogen electrode which has been assigned a standard value of Eh equals 0, it can be compared with the potentials of other solutions. The relation of the potential of an oxidation-reduction equilibrium to the potential of the standard hydrogen electrode at pH 0 is expressed by the following equation:

$$\mathrm{Eh} = \mathrm{Eo} - \frac{RT}{nF} \ln \frac{(\mathrm{Red})}{(\mathrm{Ox})}$$

Where Eh is the difference between the platinum electrode and the normal hydrogen electrode, Eo is a constant characteristic of the particular equilibrium, R is the gas constant, T is the absolute temperature, n the number of charges concerned, F the farad, Red is the molar concentration of reductant and Ox is the molar concentration of oxidant. The equation given above applies only to conditions at pH 0. At a temperature of 30° it may be shown that for each unit increase in pH there is a decrease of 0.06 volt in Eh. If hydrogen is being evolved in a solution in which is immersed a platinum electrode, the platinum surface will become saturated with hydrogen and act as a hydrogen electrode. The hydrogen absorbed on the electrode is then in equilibrium with the hydrogen ion, H^+, in the solution and with the hydrogen in the atomic condition, H. The pressure, P, under which the hydrogen is evolved is a function of the H^+ and H concentrations in the solution. Substances in the solution may then react with either hydrogen ions or water to liberate gaseous hydrogen and build upon the electrode a definite hydrogen pressure, or the reverse may occur. The hydrogen on the electrode may go into solution and cause the reduction of substances in the solution. Then, if a constant pressure of hydrogen gas is maintained at an electrode in equilibrium with a solution at a known pH, the potential at the electrode may be used as a measure of the Eh and refers to the potential produced by a definite pressure of hydrogen. The relationship is expressed by the general equation:

$$\mathrm{Eh} = \mathrm{EH} - \frac{RT}{nF} \ln \frac{\sqrt{P}}{(H^+)}$$

In a similar manner, Willis (54) has shown the relationship between Eh, pH, and oxygen pressure. His calculations show that under equilibrium conditions the intensity of oxidation should vary inversely with pH and directly with the logarithm of the oxygen pressure. On the basis of assumptions from the result of theoretical calculation the indication is that in the soil the effect of changes in the pH on the activity of oxygen should be very great, relative to the effect of changes in oxygen pressure. If equilibrium conditions could actually exist in the soil, an increase in pH could be considered as equivalent to a decrease in the activity of oxygen, but microrganisms are constantly using the oxygen, and the rate of supply of oxygen is a dominant factor. Willis found that soil suspensions are weakly poised and that there is generally a drift to the negative. Particularly was a pronounced negative drift noted in deaerated suspensions. The drift is due largely to the production of low potential material and to the depletion of oxygen. Also the drift was found to be most rapid at high pH values. Earlier work of Willis (53) suggested that the effect of the hydrogen-ion concentration on the oxidation-reduction equilibrium might be of more significance than the pH alone. In the case of the humus fraction of a peat soil, it was found that organic matter constituted an oxidation-reduction system from which the curve showing the relation of Eh to pH had a slope of—0.06 in the acid range and a zero slope in the alkaline range. Willis states that well aerated soils low in organic matter would be expected to exhibit oxygen potentials but that on the removal of free oxygen other components as iron compounds might maintain the established potential. He concludes that aerobic or anaerobic conditions cannot be defined by soil potentials.

Remezov (43) from studies on the changes of the oxidation-reduction potential in podsolised soils observed that under different degrees of swampiness the Eh varied from 11 to 353 millivolts and that the lower Eh was associated with the stronger swampiness. The determination of the potential was attended with difficulty as the potential varied greatly with time.

Bradfield and others (4) have found that measurements of the oxidation-reduction potential in soils promise to be a more useful index of subsoil drainage over a longer period of time than groundwater observations. The determinations of the potential were made in suspensions of the soil in 0.1 N sulphuric acid. By lowering the pH the concentration of the ions of the oxidation-reduction system is greatly increased and the ratio between them is not so easily disturbed, or the system is better poised. These workers observed that a change of 0.08 volt per unit change in pH fit their conditions better than the theoretical value of 0.06 volt. The experimental error in the determination of the potential was accepted as approximately 10 millivolts.

Kohnke and Bradfield (35) have concluded that particular difficulty is met with in determining the oxidation-reduction potential in soils due to the oxidizable and reducible components that occur in the colloidal state. The aqueous suspensions of these materials are not stable. The factors which influence the more permanent changes in the potential are the degree of saturation with water, temperature and the nature and amount of organic compounds present.

Robinson (44) studied the effects of submergence on a number of widely different soils and found that reducing conditions may develop within eight days. Toxicity in submerged soils is due largely to soluble iron, soluble manganese, and hydrogen sulphide or to a general reducing condition, which in itself is the main and most toxic agent. Robinson stated that the carbon dioxide produced by the microbiological decomposition of organic matter is mainly responsible for holding the iron and manganese in solution. The solubility of iron sulphide is also increased by the production of carbon dioxide. Robinson stated from the work of others that most upland crops will not tolerate more than 5 parts per million of ferrous iron in solution.

Brenchley (6) found that 2.5 parts per million of manganese in solution was toxic to peas, while barley would endure 10 parts per million. She also found that iron is antagonistic to manganese.

An increase in acidity or reduction increases the solubility of iron and manganese. McGeorge (39) observed that all soils in which the acidity was higher than pH 5.8 contained soluble salts of iron, aluminum and manganese. At pH 6.0 or above, manganese was not present in the soil solution and iron and aluminum were present only as hydrosols. Conner (16) found manganese and iron apparently to have been largely reduced and made soluble by saturating the soil with water. Unlike the iron the manganese did not rapidly oxidize in air-drying the soil.

According to Piper (41) the two forms of manganese in the soil that are important as a source of manganese for plants are replaceable bivalent manganese and manganese dioxide. The relative amount of these two forms is controlled by the soil reaction and the oxidation-reduction equilibrium. The availability of manganese is influenced by these two factors acting together. Manganese has been found to have been reduced and rendered soluble in water-logged soils as alkaline as pH 8.0. Soil conditions that favor reduction processes have been shown to increase the amount of manganese available to the crop.

Halvorson (23) has shown by calculation how the lowering of the pH or the oxidation-reduction potential will increase the amount of ferrous iron remaining in solution. Solutions in which bacteria are growing even under aerobic conditions favor the solution and reduction of ferric iron especially if the solution becomes acid.

Under anaerobic conditions heterotrophic microorganisms dissolve and reduce ferric hydroxide. The changes result from decrease in oxygen pressure and formation of acid and may occur at reactions close to neutrality. The effect of heterotrophic bacteria on the solution of iron is very important on account of the fact that they can induce changes favoring solution which do not occur spontaneously.

Harrison and Aiyer (24) observed that the gaseous products of the decomposition of organic matter in flooded rice soils consisted chiefly of methane, smaller proportions of nitrogen, carbon dioxide and hydrogen. The gases evolved from the surface of the soil consist mainly of oxygen and nitrogen. The nitrogen evolved from the immediate surface of the soil is derived largely from the atmosphere by a purely physical reaction. The absence of carbon dioxide and hydrogen from the gases evolved from the surface of the flooded rice soils was later accounted for by the fact that bacterial action takes place resulting in the reduction of the carbon dioxide by the hydrogen and the formation of organic matter or methane (26).

Harrison and Aiyer (25) have shown that the relationship between gas production in rice soils and oxygen evolution by the algal film at the immediate surface is due to symbiotic interchanges between the microorganisms found in the film. Methane and any hydrogen which reach the surface are oxidized with the production of carbon dioxide and water. The carbon dioxide is then decomposed largely by algae with the evolution of oxygen. Also, there appear to be present autotrophic microorganisms which assimilate carbon dioxide and methane to produce organic matter that may be utilized by the organisms which are responsible for the oxidation processes. The oxygen liberated at the surface of the soil is dissolved in the water entering the soil and is utilized for root aeration. The aeration of a flooded rice field depends on the rate of organic decomposition or the production of the gases, particularly methane, hydrogen and carbon dioxide, on the activity of the surface film, and on the permeability of the soil to the downward movement of the water charged with a high concentration of dissolved oxygen. In very impermeable soils, it was found that, due to the inability of oxygenated water to penetrate the soil, root growth was restricted to the very top of the soil and stunted plants and poor crops were produced.

The root-rot of rice, "mentek," in Java is a disease or condition in which the root is incapacitated to supply the plant with nutrients and water and is caused by the lack of oxygen in the soil and consequent accumulation of reducing substances about the roots. Van der Elst, according to Copeland (17), has proven the relationship of lack of aeration to development of the disease. He found that in water cultures where the oxygen was excluded from the water some symptoms of root-rot appeared within two days. When 100 parts per million of ferrous sulphate was added to the culture solutions, typical symptoms of "mentek" were produced within one day. In practical rice culture the root-rot occurs exclusively in irrigated rice fields and is found in infertile shallow soils which have poor structure and imperfect drainage.

Bonazzi (3) has found that the primary roots of rice are obligate aerobic organs and that under the conditions of anaerobic germination toxic substances, hydroxy acids of the lactic acid type, alcohol and acetone, accumulate in rice seedlings. Among the products of anaerobic germination of rice there are some, especially the hydroxy acids, that have a toxic action for the development of the radicle in new plantings made in the presence of oxygen. Studies on the reduction of nitrates under aseptic conditions by extracts from macerated rice plants indicated that there exists in rice plants a very active reducing mechanism.

Jones (32) in studying the effect of continuous submergence on the germination of rice in soil found that if the rice seed were placed one inch or deeper into clayey soils and the soils kept continuously submerged, normal germination did not occur and 20 per cent or less seedlings developed. Apparently there was insufficient oxygen under such conditions to initiate the growth of the radicle. Results from germination of rice in pots into which oxygen was forced indicated that the lack of oxygen is the principal factor causing abnormal germination and seedling development when rice is planted to any appreciable depth in continuously submerged soils.

Cannon (14) from studies on the effects of varying the amounts of carbon dioxide and oxygen on the growth of rice seedlings in soil cultures through which the gases were forced observed that the roots of seedling rice are capable of maintaining growth in percentages of carbon dioxide up to 49 per cent and on the other hand that growth will go on, although slowly, in as little as 0.5 per cent oxygen, which indicates that rice is adaptable to poor aeration.

The full importance of concentration of carbon dioxide and of the diffusion of carbon dioxide and oxygen in flooded soils has not been extensively studied, but valuable inferences can be drawn from the results of studies on drained soils (48). Smith and Brown (49) found that the percentage of carbon dioxide in the soil air in cropped soils was much higher than in fallow soils. These workers also found that the carbon dioxide in soils was produced by the crop plants and by the microorganisms. They assumed a small amount to be produced by chemical action. Deep-rooted leguminous plants were found to produce more carbon dioxide than non-leguminous plants. There was an average percentage of 1.84 carbon dioxide in the soil air under alfalfa, 1.15 under corn, and 0.43 under fallow.

Buckingham (8) measured the rate of the diffusion of carbon dioxide, nitrogen and oxygen through partially moist soils and found the rate of diffusion of the gases to be determined mainly by the total porosity of the soil, and that rate of diffusion was approximately proportional to the square of the porosity.

Keen (34) states that the rate of the diffusion of a gas through a soil depends mainly on the total free pore space and not to any great extent on the dimensions of the individual pores. Although Keen's equations apply only to the diffusion of gases through the free pore space in soils, he has suggested the importance of aeration by movement of water saturated with the gases. He has also pointed out the very important fact that minute pores would tend to be closed with water and especially would this effect be increased by colloidal materials that swell in water.

Buehrer (9) has shown that the relation between the structure constant and the porosity of soils is not simply linear, as would be expected if all pores were continuous for gas or liquid flow. Apparently a certain proportion of the channels is closed at one end and unless, through the action of roots or other agencies, these channels become continuous they do not contribute to the flow of either gases or liquids.

The importance of carbon dioxide in the absorption of the nutrients, particularly of phosphorus and potassium, has been described by workers in Arizona. Breazeale (5) has shown that plants can absorb the carbonate ion from soil carbonates, but he did not consider that the carbon absorbed through the root was of major importance in the photosynthetic process in the leaves. The absorption of the carbonate ion does not appear to take place unless some soluble base is present. Breazeale concluded that the plant probably absorbs the carbonate ion or exudes carbon dioxide for the purpose of maintaining equilibrium in its tissues or in the solution in which it is growing. Buehrer (10) has pointed out that the $^{-}H_2PO_4$ is the phosphate ion likely to be in greatest abundance within the range in reaction where phosphate absorption by the plant is optimum and must be the ion upon which the plant largely feeds. If the phosphate ion is not present in this form, the plant can make the the conversion by the exudation of carbon dioxide. McGeorge (40) has found that phosphate absorption by the plant is most active between pH 5.5 and 6.8, and expressed the view that there can be no absorption of phosphate from a calcareous soil in the absence of carbon dioxide. In soils very low in organic matter the exudation of carbon dioxide from plant roots is the main source. Where the rate of diffusion of carbon dioxide is restricted as in the case of puddled soils, the exudation of carbon dioxide may become toxic due to slow, outward diffusion of carbon dioxide and slow, inward diffusion of oxygen. A certain balance between carbon dioxide and oxygen must exist. Demonstrations in water cultures have indicated that there is no absorption of phosphate in an excess of carbon dioxide. McGeorge concluded that the proper balance between carbon dioxide and oxygen is impossible in puddled soil because of restricted diffusion of carbon dioxide and oxygen.

Russell (46) has summarized the evidence regarding the losses of nitrogen from soil and drawn the conclusion that there is no clear proof of the total loss of soil nitrogen by denitrification in soils under natural conditions or even in soils which have been temporarily water-logged. However, the loss of nitrogen by denitrification through bacterial action on decomposable organic matter under anaerobic conditions in soil cultures has been demonstrated.

Leather (36) determined the composition of gases from swamp rice soils. The amount of nitrogen evolved from plots of manured and unmanured soils showed that much greater quantities of nitrogen were evolved from the manured plots. It was inferred that part at least of the nitrogen was derived from the soil and green manure. Through a comparison of the ratio of nitrogen to argon, dissolved in water which had been shaken with air, to the ratio of the two gases present in rice land, Leather concluded that a high proportion of the nitrogen was derived from the soil and manure.

Kapp (33) found that the lack of nitrogen is responsible for most of the abnormal growth of rice on Crowley and Clarksville soils and that large applications of nitrogen in the forms of sodium nitrate and ammonium sulphate made every two weeks increased greatly the yields of rice under controlled conditions. Nitrogen was lost from the fertilized soil after submergence. Nitrates were lost more rapidly than ammonium forms. Nitrites did not accumulate in submerged soils in sufficient amounts to be toxic to rice. Nitrogen was not lost as ammonia. Kapp stated that the fertility of the soil must be maintained by a system which will increase the soil organic matter and which will allow the organic matter to partially decompose under aerobic conditions to insure the liberation of sufficient nitrogen after submerging.

Studies on the nature of the rice soils in the coastal prairies of Louisiana show that continuous flooding causes marked changes in the physical and chemical properties of these soils (18). The native characteristics of the soils are such that they tend to become compacted (28,18). The tendency toward deflocculation becomes especially marked as the soil organic matter is depleted from cropping and as irrigation is continued. In cases where salt water has been used in the irrigation of rice the soils have become more alkaline and deflocculation is most markedly developed.

An extensive review on the results from fertilizers on rice by the author (51) indicates that the continuous culture of irrigated rice on soils low in organic matter or through which water drains slowly causes the development of toxic or inhibitory conditions which lower the yield of rice. Under the conditions of poor aeration the lowered oxygen supply in the soil and the accumulation of reduced substances slow up the decomposition processes of bacteria which liberate nitrogen from soil organic matter and cause the soluble phosphates to be changed to less available forms. After deflocculation, extremely poor drainage and the consequent poor aeration have developed in rice soils, the simple application of commercial fertilizers will not be effective, but by draining the land and turning under legumes the yields of rice may be increased.

The results of previous work and an analysis of data in the literature show that the decomposition of organic matter in waterlogged soils causes the accumulation of reduced products. The actual amounts of the reduced products that are likely to be toxic to irrigated rice have not been determined. Determination of the intensity of reduction or the oxidation-reduction potential in soils is attended with considerable difficulty and the results secured can be considered only as approximate values. It has been shown that the use of the oxidation-reduction potential as an index of aeration has serious limitations due to the fact that systems other than the oxygen system may maintain relatively high potentials. Data in the literature indicate that nitrogen may be lost from flooded soils and that the low availability of nitrogen to irrigated rice is a most serious difficulty. The aeration of a flooded soil depends on the downward diffusion of oxygen and on percolation carrying dissolved oxygen downward. There is no obvious mechanism to supply free oxygen in a deflocculated and impermeable soil under flooded conditions. The slow diffusion of carbon dioxide and oxygen on the accumulation of soluble ferrous iron in flooded soils, particularly if the soils were alkaline, would reduce the availability of phosphorus to very low values.

EXPERIMENTAL

Experimental Materials and Methods

The soil used in these experiments was taken from a very fertile area of Sharkey clay loam located on the farm of the Louisiana Agricultural Experiment Station at Baton Rouge and from areas of virgin and cultivated Crowley silt loam located on the Rice Experiment Station at Crowley.

The Sharkey clay loam is a very extensive Mississippi first bottom soil. The A horizon is dark-brown finely granular clay loam to a depth of 8 inches. The B horizon consists of a dark-drab to bluish clay, which is sticky and plastic when wet and very crumbly or coarsely granular when dry, extending to a depth of about 24 inches below the A. Below this is a yellowish plastic silty clay loam to a clay parent material.

Analyses were made on samples from the A and B horizons, but only soil taken as representative of the A horizon was used in the pot tests. The agricultural history of the soil is not definitely known except that it has not been planted to rice within the last ten years during which time it has been in rotation of sugarcane, corn and soybeans.

The Crowley silt loam soil is a coastal prairie soil. In the virgin state the A horizon consists of 6 inches of dark-gray friable finely granular silt loam which contains a few pockets of ashy siliceous material extending into the B. The B horizon extends from the A to a depth of 24 inches and consists of a brownish gray silt loam which has a granular to slightly columnar structure. The C horizon extends from below 24 inches and is a gray clay mottled brown and contains a small number of iron concretions.

The Crowley silt loam soil which has been used in these experiments and designated as deflocculated Crowley silt loam differs in physical properties from the virgin soil. The differences have been due to cropping the soil to irrigated rice over a period of forty-four years. The soil has not been planted to rice continuously but in general has been in rice two years and then out for one year. When it was kept out of rice, it was usually planted to soybeans or left fallow. The water used in the irrigation has been about neutral in reaction and has contained about 300 parts per million of soluble salts, of which about 60 parts per million was sodium. The irrigation water has been pumped from a deep well and its analysis shows it to be good water for irrigation. The profile of the deflocculated Crowley silt loam shows an A horizon having an average depth of 6 inches of gray silt loam which has a platy structure, brown iron stains around the channels of old roots, numerous iron concretions below 4 inches and numerous tongues of ashy gray siliceous material extending to depths of 20 inches or more into or through the lower horizon. The upper part of the B horizon from a depth of 6 to 15 inches is a light-gray streaked with brown silt loam having a compact coarsely granular structure. The lower B extends from a depth of 15 to 24 inches and consists of a purplish brown clay which has a very compacted blocky to columnar structure. Apparently the C horizon of the deflocculated soil is similar to the C of the virgin soil. Analyses were made on samples from the A, B, and C horizons of the virgin and on only the A and B horizons of the deflocculated soil. Soil from the A horizon was used in the lysimeter and pot tests.

The total analyses were made according to the method of the Bureau of Chemistry and Soils as proposed by Robinson (44).

The determination of the available nutrients was made according to the method of Reed and Sturgis (42). This method is based on the common procedure of determining exchangeable bases by the use of 0.05 N hydrochloric acid. The amounts of exchangeable or easily soluble bases have been considered as fair indices of availabilities of the basic ions (29, 30, 19, 21). The rate of increase in the solution of phosphorus from a given weight of soil through increasing the proportion of 0.05 N hydrochloric acid to the sample was used as a measure of the availability of phosphorus.

Exchangeable hydrogen and the degree of saturation were determined by the use of barium acetate. This reagent was used on the basis of the fact that extensive tests had shown it to be very effective in replacing exchangeable hydrogen (52).

The pH was determined colorimetrically on clear soil extracts which were obtained by the use of the soil itself as a filter in a perforated test tube. The results from the colorimetric procedure were checked by the use of the hydrogen electrode.

The reducing capacity of the soil was determined by a procedure which was developed during the progress of the investigation. A 25-gram portion of the sample of moist soil which had just been taken from a depth of 5 inches was transferred immediately by washing with 25 milliliters of 0.1 N potassium dichromate and 100 milliliters of 0.5 potassium sulphate to an Erlenmeyer flask. The flask was stoppered and the soil and oxidizing solution shaken and allowed to stand for 2 hours. The solution was filtered off, a 25 milliliter aliquot taken and the excess potassium dichromate determined iodimetrically. After the potassium iodide was added, it was found necessary to titrate with the thiosulphate within five minutes. The amount of the dilution of the oxidizing solution by the soil moisture was calculated and the correction applied to the results which are given as the volume of 0.1 N potassium dichromate reduced per 10 grams of dry soil. The procedure is open to the criticism that some of the reduced organic compounds would not be oxidized and the less soluble inorganic substances would not be acted on. The relative high values obtained and the ease with which duplicates can be checked do, however, recommend its use in a comparative study.

The oxidation-reduction potential of the soil was determined in a manner similar to the procedure recommended by Allyn and Baldwin (1) and Brown (7). It was found that the use of a vacuum-tube potentiometer as recommended by Allyn and Baldwin was an unnecessary refinement in reading potentials in highly reducing soils due to a rapid negative drift which would not allow for determinations that could be checked more closely than 10 millivolts. The time consuming manipulation of Brown for seating the electrode in the soil could not be used in highly reducing soils because of the fact that any considerable exposure of the sample to the air may produce marked changes in the values obtained. The samples were taken as in the procedure described for the determination of the reducing capacity. Enough of the fresh sample to fill a small beaker to a depth of about an inch was covered with freshly distilled water and allowed to stand for 30 minutes. Then two heavy wire electrodes of bright platinum which had been cleaned with nitric acid, washed and allowed to stand in distilled water were placed in the wet soil and contact made with a saturated calomel half-cell through an agar bridge and a potentiometric set-up. The e. m. f. was estimated first by making contact through one electrode and then by taking a final reading from the other within 10 minutes. Due to slow poising in soils which have been well aerated and to a rapid negative drift in soils which have become reducing, the values found and reported in volts are not considered significant beyond the second decimal. The data were corrected to the standard normal hydrogen electrode, by adding the value of the saturated calomel half-cell to the observed e. m. f. with the correct sign. The values are reported as Eh, without corrections having been applied for pH.

The soluble substances in the Sharkey soil were obtained by extracting the soil with water according to the Bureau of Soils method (47). The 1:5 water extract method could not be used on the Crowley soils because of the high degree of colloidal dispersion in the soil; so it was necessary to determine the soluble substances on the percolate secured by opening the bottoms of the pots and lysimeters periodically and collecting the percolate. Percolation was forced through the soil by keeping a head of fresh water on top of the soil. The bottoms of the pots and lysimeters contained a layer of acid-washed sand which permitted the maximum percolation that could be obtained under the conditions. Actually the percolate used in the analyses might be considered as a soil solution under saturated conditions which had been more or less displaced by water.

The fact that varying the ratio of soil to water causes variations in the amounts of the different ions, except the nitrate ion, present in the soil solution or water extracts of the soil (12, 11) does not permit an accurate comparison of the solubilities of the various ions present in the different soils.

The nitrates, nitrites, iron, manganese, aluminum, phosphorus and silica in the water extracts and percolates were determined by conventional colorimetric procedures.

Ammonia nitrogen was determined by replacing the ammonia with 0.5 N potassium chloride and then by distilling the ammonia over into standard acid and titrating it.

Soluble sodium was determined by the magnesium uranyl acetate method as outlined by Lemmermann (37).

All the determinations were made in duplicate and all the soil treatments were duplicated.

Experimental Results

The results of total analyses of the A and B horizons of the Sharkey clay loam are shown in table 1. It had been observed that the soil was very high in available phosphorus (50) and that sulphides were readily produced after the soil had been water-logged for a few days. These conditions indicated that the soil was high in total phosphorus and sulphur. The analytical results show that the soil has a high phosphorus content, but the sulphur content is not so high as had been expected. It is relatively little higher in sulphur than other soils of the region (20). The data show that the B horizon has a higher nitrogen content than the A. This is a very significant condition. The higher content of nitrogen in the deeper horizon may be due to the effects of less aeration and lower temperature on the rate of organic decomposition.

Table 1.—Total analyses of the A and B horizons of Sharkey clay loam.

Constituents	Sharkey A	Sharkey B
SiO_2	72.00 %	62.70 %
TiO_2	0.25	0.33
Fe_2O_3	5.32	6.15
Al_2O_3	13.16	19.13
MnO	0.067	0.069
CaO	2.41	2.68
MgO	1.30	1.65
K_2O	0.86	0.97
Na_2O	0.85	0.69
P_2O_5	0.28	0.24
SO_3	0.12	0.08
Cl	0.028	0.025
Ignition Loss	4.15	5.22
N	0.108	0.119

The data in table 2 indicate that the Sharkey clay loam contains relatively large amounts of the exchangeable or easily soluble basic elements, and especially does it contain a large amount of easily soluble phosphorus. It can be seen from the data that, as the ratio of soil to the dilute acid used in extracting the phosphorus was decreased, there was a rapid increase in the amount of soluble phosphorus per unit weight of soil. Preliminary work had shown that it was not practical to carry the ratio of soil to 0.05 N hydrochloric acid to less than 1:100. It was also found that when this ratio of soil to acid was used all the phosphorus that could be dissolved by the acid was put in solution. The amount of phosphorus which is put into solution when the 1:100 ratio of soil to acid is used may be taken as an indication of the maximum amount of easily soluble or available phosphorus. It has been shown that soils which show 60 parts per million or more of soluble phosphorus by the method used contain sufficient phosphorus for normal crop growth (42). On a comparative basis the results show that the soil is very high in available phosphorus.

Table 2.—Available nutrients and degree of saturation in the A and B horizons of Sharkey clay loam.

	Sharkey A	Sharkey B
Total N %	0.108	0.119
Available K, p. p. m.	460	300
Available Ca, p. p. m.	4600	5020
Available Mg, p. p. m.	468	634
Available P, p. p. m.		
1:10 soil:acid	30	42
1:40 soil:acid	132	152
1:100 soil:acid	330	250
1:100 soil:H_2O	10	7
Exchangeable H, m. e. per 100 g.	0.68	0.68
Total exchange, m. e. per 100 g.	27.9	43.6
Degree of sat. %	97.6	98.4
pH	7.2	7.4

In order to arrive at quantitative determinations on the effects of organic matter and flooding on reduction, the accumulation of reduced substances, the solubility of phosphorus, and the changes in nitrogen, the Sharkey soil was treated in 3-gallon pots. One series of treatments, numbers 1 to 4 inclusive, was kept at 50 per cent of the moisture holding capacity. Another series, numbers 5 to 8, was kept saturated with water, but was not allowed to drain. The pots containing the soil were kept in a constant-temperature room at 30°. The treatments were as follows:

1. Check, untreated soil.

2. Soil to which was added soybeans. The whole plants were ground so as to pass a 2 mm. sieve, and used in an amount equivalent to 0.50 per cent organic matter and 0.0094 per cent nitrogen on the basis of the soil mixture.

3. Soil to which was added cane trash in an amount sufficient to add 0.50 per cent organic matter and 0.0037 per cent nitrogen.

4. Soil and cane trash as in treatment 3 with a supplement of 0.0057 per cent nitrogen as ammonium sulphate and 0.013 per cent calcium as the carbonate.

5–8. Treatments similar to 1 to 4, except that they were kept saturated with water, while treatments 1 to 4 were held at optimum moisture.

Distilled water was used in keeping up the moisture supply. The soil was not cropped or allowed to drain.

Table 3.—Reducing capacity, oxidation-reduction potential and concentrations of substances 3 weeks after flooding Sharkey clay loam in 3-gallon pots.

Treatment	Ml. 0.1 N ox. soln. reduced by 10 g. soil	Eh in volts at 31°	pH	Nitrate N p. p. m.	Ammon. N p. p. m.	Soluble Fe p. p. m.	Soluble Mn p. p. m.	Soluble P p. p. m.	Sulfate S p. p. m.	Sulfide S p. p. m.*
1	0.4	0.47	6.7	21.5	2.4	trace	none	1.4	20	0.6
2	0.4	0.46	6.9	26.0	2.7	trace	none	1.6	22	0.5
3	0.2	0.45	6.7	trace	2.5	trace	none	1.9	21	0.0
4	0.4	0.46	6.9	25.5	3.1	trace	none	1.4	63	0.5
5	2.0	0.24	7.0	none	22.3	1.8	2.8	0.4	0	13.0
6	6.0	0.05	7.0	none	54.6	2.4	2.3	0.4	0	10.4
7	4.7	0.06	6.9	none	10.6	2.9	2.9	0.4	0	11.9
8	5.0	0.07	7.0	none	36.7	1.3	2.8	0.4	0	29.9

*Insoluble in water, soluble in dilute hydrochloric acid.

After three weeks the soil under the different treatments was sampled and the various determinations made. The results are given in table 3 on the basis of the dry soil.

The data show that decomposition of organic matter did not cause the accumulation of reduced products or lower the oxidation-reduction potential when the soil was kept at optimum moisture. Decomposition of organic matter under the water-logged conditions increased markedly the amount of reduction in the soil and lowered the Eh to almost the value of the hydrogen electrode. The pH of the soil was increased only slightly as the Eh was lowered. Theoretically, lowering the oxygen pressure should increase the pH (54). An increase in ferrous iron as the hydroxide under the reducing condition would also tend to give a higher pH (31). Although there was an accumulation of soluble iron and manganese, the amounts were lower than expected. Since water soluble sulphides could not be detected, it is possible that the iron and manganese were precipitated largely as sulphides. Nitrates were reduced to ammonia under the water-logged conditions, but nitrites did not accumulate to more than 0.1 p.p.m. The results show that the decomposition of the different forms of fresh organic matter was about equally effective in lowering the oxidation-reduction potential and in increasing the general reducing conditions. The reduction in the check or untreated soil was neither so intense nor of as high capacity as in soil which had been treated with fresh organic matter.

The results given in table 4 show the reducing capacity, the Eh, and the gains or losses in nitrogen in the Sharkey soil, three months after the treatments were applied. It can be seen that the amount of reduction in all the treatments that were water-logged increased with time. The Eh, however, was only slightly lowered as the time following the application of the treatment increased beyond three weeks. The water-logged check was an exception, and the slow rate of fall in the Eh in this treatment which contained no fresh organic matter indicates that the development of a low oxidation-reduction potential is largely dependent on the rapid decomposition of fresh organic matter. The most significant fact shown by the data in table 4 is that there was a small gain in total nitrogen by fixation in the treatments where fresh organic matter was added to the soil and the moisture kept at optimum, but when the soil was water-logged, there was a loss in total nitrogen by reduction or denitrification. However, it is important to note that the soil had to be dried after being sampled wet, and although it was dried as quickly as possible at 40°, there is the possibility that some nitrogen was lost in going from the wet to the dry condition.

Table 4.—Reducing capacity, oxidation-reduction potential and the accumulation of nitrogen in Sharkey clay loam 3 months after flooding.

Treatment Number	Ml. 0.1 N ox. soln. reduced by 10 g. soil	Eh in volts at 31°	pH	Nitrate–N p. p. m.	Ammon.–N p. p. m.	Total N %	N lost or gained %
1	0.5	0.49	6.7	62.0	7.9	0.0800	0.0000
2	0.5	0.49	6.7	97.5	11.1	0.0921	0.0027
3	0.4	0.49	6.7	53.0	8.3	0.0847	0.0010
4	0.5	0.49	6.7	91.5	10.7	0.0935	0.0041
5	6.5	0.07	7.0	none	47.7	0.0760	–0.0040
6	6.8	0.04	7.1	none	73.3	0.0846	–0.0048
7	6.9	0.04	7.0	none	44.4	0.0810	–0.0027
8	7.3	0.04	7.1	none	54.5	0.0858	–0.0046

Table 5 shows the effects of irrigation and cropping over a period of forty years on the chemical changes in the profile of Crowley silt loam. The data indicate that silica and iron oxide have increased in the A horizon of the cultivated soil which has become deflocculated. There has been a marked decrease in nitrogen in the cultivated soil, especially in the A horizon. Apparently the phosphorus lost from the soil has been removed by cropping, since the results show that there has been no downward movement of phosphorus.

Table 5.—Total analyses of virgin Crowley silt loam and of deflocculated Crowley silt loam that had been cultivated for 40 years at the Agricultural Experiment Station at Crowley, Louisiana.

Constituents	Virgin Crowley A	Virgin Crowley B	Virgin Crowley C	Defloc. Crowley A	Defloc. Crowley B
SiO_2	78.50%	75.60%	67.14%	81.14%	77.17%
TiO_2	0.60	0.48	0.48	0.35	0.35
Fe_2O_3	1.70	3.45	4.17	3.13	3.41
Al_2O_3	7.85	11.37	15.63	7.00	9.98
MnO	0.22	0.03	0.06	0.24	0.17
CaO	0.72	0.83	1.13	0.84	0.93
MgO	0.43	0.54	0.79	0.42	0.46
K_2O	0.42	0.41	0.93	0.78	0.79
Na_2O	0.68	1.08	0.73	0.78	0.60
P_2O_5	0.032	0.027	0.031	0.025	0.023
SO_3	0.245	0.245	———	0.193	0.210
Cl	0.00	0.02	0.00	0.01	0.01
Ignition Loss	7.43	5.43	7.45	5.15	5.77
N	0.201	0.111	0.125	0.080	0.081

The results in table 6 show that there has been an increase in the exchangeable bases in the A and B horizons of the cultivated Crowley soil. This has been reported before in work in which the determination of the exchangeable bases had been made by the ammonium acetate method (18). The pH has also increased in the cultivated soil; while at the same time, the degree of saturation has not increased. The only mechanism that has been suggested for this type of build-up in exchange compounds is the recombination of the acidic and basic groups to form new isoelectric compounds (38). The available phosphorus in the virgin soil is very low and the availability has been further decreased in the cultivated soil. Bartholomew (2) found from studies on changes in the availability of phosphorus in irrigated rice soils, which are similar to the Crowley soil, that the decrease in the availability could be attributed to the high calcium bicarbonate content of the irrigation water. Hibbard's (27) recent review of the factors influencing the fixation of phosphorus indicates that the increase in pH and exchangeable calcium would decrease the available phosphorus. However, the data in tables 3 and 7 indicate that the low availability of phosphorus shown here may have been due to the fixation of phosphorus as an iron phosphate under reducing conditions.

Table 6.—Available nutrients and degree of saturation in virgin Crowley silt loam and deflocculated Crowley silt loam that had been cultivated for 40 years at the Agricultural Experiment Station at Crowley, Louisiana.

	Virgin Crowley A	Virgin Crowley B	Virgin Crowley C	Defloc. Crowley A	Defloc. Crowley B
Total N %	0.201	0.110	0.120	0.080	0.081
Available K, p. p. m.	100	32.5	90.4	61.4	74.0
Available Ca, p. p. m.	820	520	1080	1200	644
Available Mg, p. p. m.	294	325	702	632	516
Available P, p. p. m.					
1:10 soil:acid	1.25	0.75	0.75	0.50	0.50
1:40 soil:acid	3.00	1.60	1.60	1.40	1.40
1:100 soil:acid	12.50	6.00	6.00	4.50	4.50
1:100 soil:H_2O	trace	trace	trace	trace	trace
Exchangeable H m. e. per 100 g	9.7	11.4	11.0	9.1	11.2
Total exchange m. e. per 100 g.	19.9	22.0	28.9	18.9	21.3
Degree of sat. %	51.2	48.2	61.9	51.9	47.4
pH	6.0	5.8	6.1	7.1	6.1

The effects of reduction on the soluble constituents and yields of rice in the deflocculated Crowley silt loam were obtained by treating 9 kilograms of the soil in 3-gallon pots. The treatments were applied, the soil made up to optimum moisture and the rice planted on December 19. The rice was flooded with distilled water three weeks after germination and kept flooded until mature. It was necessary to move the pots from greenhouse conditions into field conditions on April 21, on which date the samples were taken for the analyses reported in table 7. The treatments applied to the soil were as follows:

1. Check, untreated soil.
2. Soil and 0.50 per cent organic matter in the form of coarsely ground soybean hay.
3. Soil, soybeans and 0.003 per cent P_2O_5 as calcium acid phosphate.
4. Soil, soybeans and 0.006 per cent K_2O as potassium sulphate.
5. Soil, soybeans, P_2O_5 and K_2O.
6. Soil and 0.004 per cent N as ammonium sulphate.
7. Soil, N, and P_2O_5.
8. Soil, N, and K_2O.
9. Soil, N, P_2O_5 and K_2O.

The data show that the soil under the rice was highly reducing and that the treatments which contained the organic matter caused the greatest reduction and accumulation of reduced products. There were large accumulations of soluble iron and manganese in the soil solution. The most noticeable effect associated with the experiment was the formation of an incrustation of iron and manganese oxides on and around the older roots of the rice. This incrustation began to form on the roots about 10 days after flooding. A microscopic examination of freshly cut sections of the roots stained with an acid solution of potassium thiocyanate shows that the iron in the incrustation penetrated the outer layer of cells. Although the addition of the organic matter increased the amount of iron in the soil solution, apparently the tendency is for the iron not to be precipitated on the roots so long as there is an active production of carbon dioxide. There was a relatively small amount of soluble aluminum in the soil solution, and the different treatments seem to have had little or no effect on the soluble aluminum. Extremely small amounts of soluble phosphorus were found, even where phosphorus had been added in the treatment. The decomposition of the fresh organic matter caused a very slight increase in the phosphorus appearing in the soil solution. The amount of soluble silica in the soil was high, but it was not changed greatly by any of the treatments.

Table 7.—Reducing capacity, oxidation-reduction potential and constituents in the soil solution of deflocculated Crowley silt loam which was planted to rice in 3-gallon pots and kept continuously flooded for 3 months.

Treatment	Ml. 0.1 N ox. soln. reduced by 10 g. soil	Eh in volts	pH	Fe p. p. m.	Mn p. p. m.	Al p. p. m.	P p. p. m.	SiO_2 p. p. m.
1	4.0	0.19	7.4	1.2	13.3	0.8	0.02	21
2	6.6	0.09	7.3	15.0	14.3	0.9	0.03	22
3	5.1	0.10	7.3	13.0	8.0	0.9	0.03	21
4	6.7	0.09	7.2	18.0	9.5	0.8	0.03	24
5	4.6	0.15	7.2	26.0	11.1	1.0	0.03	23
6	3.3	0.18	7.4	8.0	------	1.2	trace	24
7	3.9	0.17	7.5	10.9	------	0.9	0.02	25
8	3.4	0.20	7.8	4.6	------	1.1	trace	30
9	2.9	0.19	7.2	8.0	------	1.0	trace	24

In the effects of the various treatments given above on the yields of rice it was very obvious that the treatment of soybeans P_2O_5, and K_2O gave the greatest increase, which was 136 per cent more than the yield of the check. The addition of soybeans and P_2O_5 increased the yield 118 per cent; soybeans and K_2O gave an increase of 92 per cent. None of the treatments which did not contain organic matter produced significant increases. Apparently, the presence and decomposition of the organic matter had a most marked effect on the flocculation of the soil. The root development in the pots containing the organic treatments was much greater, and the roots were much less coated by the iron incrustations.

In the progress of the work, it had become apparent that the decomposition of fresh organic matter in a water-logged soil is the most important factor affecting the intensity and amount of reduction. To test the effect of the soil organic matter in a sample of the deflocculated Crowley soil from which a crop of rice had just been removed in comparison with fresh organic matter which was added to the same soil, treatments of coarsely ground soybean hay, gypsum and sulphur were added, in the amounts indicated in table 8, to 500-gram portions of the soil in 1-liter beakers. The soil was submerged to a depth of four inches with distilled water and kept submerged at a constant temperature of 30° for one month. The Eh was determined daily. The data indicate that the rate of decomposition of soil organic matter in a deflocculated soil which had just been cropped under irrigated conditions and to which no fresh organic matter had been added was too slow to lower the Eh more than 0.13 of a volt within a month. The reducing intensity in the soil without fresh organic matter was too low to effect reduction of sulphates. In the soil to which fresh organic matter was added the maximum intensity of reduction developed within 19 days and sulphides accumulated after the Eh was lowered beyond 0.34. The pH in the above treatments varied from 7.0 to 7.2. This variation in the pH was not considered of any significance in interpreting the results. The results given in table 8 suggest that the use of the oxidation-reduction potential in following the course of reduction in a soil is only of general value. The virgin Crowley silt loam in a well drained state has an Eh of 0.53. After the soil has been irrigated for a number of years and then aerated and dried, the Eh is 0.67. Evidently there is some system such as the inorganic iron system, which increases under the conditions of wetting and drying, that imposes a higher potential in the irrigated soil when it is dried than existed in the normal virgin soil under the same degree of aeration.

Table 8.—Changes in the oxidation-reduction potential in the surface 3 inches of Crowley silt loam kept under 4 inches of water for 30 days at 30° Centigrade.

Days of submergence	Eh in volts				
	Soil alone (check)	Soil + 0.5% O. M.	Soil + O. M. .18% $CaSO_4$	Soil + O. M. .04% S	Soil + .18% $CaSO_4$
0	0.67	0.67	0.67	0.67	------
1	0.66	0.44	0.63	0.48	------
3	0.66	0.19*	0.36*	0.34*	------
4	0.66	0.14	0.17	0.22	------
5	0.66	0.12	0.14	0.14	------
6	0.65	0.13	0.13	0.12	------
7	0.65	0.12	0.13	0.12	------
8	0.64	0.12	0.12	0.12	------
10	0.64	0.10	0.10	0.10	------
11	0.63	0.11	0.10	0.10	------
12	0.61	0.10	0.11	0.11	------
13	0.61	0.10	0.10	0.10	------
14	0.60	0.11	0.11	0.10	------
15	0.61	0.10	0.09	0.10	------
17	0.55	0.10	0.09	0.10	0.52**
18	0.54	0.10	0.10	0.10	0.51
19	0.55	0.09	0.09	0.09	0.49
20	0.55	0.09	0.09	0.09	0.50
21	0.54	0.09	0.09	0.09	0.50
22	0.54	0.09	0.09	0.09	0.49
24	0.54	0.09	0.09	0.09	0.49
25	0.54	0.09	0.09	0.09	0.48
26	------	------	------	------	0.48
27	------	------	------	------	0.48
28	------	------	------	------	0.47
29	------	------	------	------	0.47
30	------	------	------	------	0.47

*From this point on, tests indicated that hydrogen sulfide was present.
**This treatment was started late.

Observations made in studying the profile of the deflocculated Crowley soil and results from chemical analyses indicated that some practical method for flocculating the soil and decreasing the alkalinity needed to be devised. Seven-kilogram portions of the soil were placed in 8-liter pyrex percolators which had been set into a fixed housing so that only the tops of the percolators were exposed to the weather. The bottoms of the percolators were fitted with perforated porcelain plates and an inch layer of acid-washed sand was placed on top of the plates. Traps which would not allow air to enter the percolators from the bottom were fitted to the outlets. Large receiving bottles were then connected through the trap tubes to outlets of the percolators. In effect the set-up was equivalent to a set of small lysimeters. The treated soil was placed in the lysimeters on May 21. The soil was made up to optimum moisture and allowed to stand until June 1, when it was set to rice plants which were six inches high at the time of transplanting. The soil was flooded immediately and was kept flooded, except at the time of harvesting, for over a year. These lysimeters, as well as all the pots described in the following experiments, were exposed to the weather in the field and distilled water was added to supply the water not furnished by the rainfall. The treatments were kept submerged to a depth of four inches. The treatments consisted of the application of organic matter as coarsely ground soybean hay, gypsum, lime as calcium carbonate, and sulphur as powdered sulphur. The amounts and combinations of the different materials are indicated in table 9, which also shows the effects of the treatments on the yield of rice. The data show organic matter alone proved the most beneficial of the single treatments. Somewhat higher yields were secured with organic matter and gypsum and from organic matter, sulphur and lime, but an inspection of the roots of the rice showed that where sulphur or gypsum had been applied there were heavy deposits of black sulphides on the rice roots. In the treatments where either the sulphur or gypsum was added without organic matter the yields were reduced. The application of sulphur or gypsum to the soil immediately before planting rice in soil where the sulphates cannot drain out of the soil is very harmful to rice, due to the fact that the sulphates will be reduced to sulphides which may be toxic to rice at high accumulations.

Table 9.—Effects of treatments on yield of rice in deflocculated Crowley silt loam in 8-liter lysimeters.

Treatment	Yield of grain in grams per lysimeter	% gain or loss
1 Check, no treatment	5.2	0.0
2 0.80% organic matter	11.9	127.8
3 0.198% $CaSO_4.2H_2O$	2.3	– 51.7
4 0.12% $CaCO_3$	4.8	– 7.7
5 0.04% S and .12% $CaCO_3$	3.5	– 32.7
6 0.04% S	2.8	– 46.2
7 0.198% $CaSO_4$ and .80% organic matter	12.5	140.5
8 0.12% $CaCO_3$ and .80% organic matter	10.8	106.7
9 0.04% S and .80% organic matter	10.3	98.2
10 0.04% S and .80% organic matter and .12% $CaCO_3$	12.4	137.9

Table 10.—Effects of treatments on the rate of percolation at different intervals after flooding in deflocculated Crowley silt loam which had been placed in 8-liter lysimeters and cropped to rice.

Treatment	Percolation in c.c. per hour at intervals after flooding								
	6 days	8 days	15 days	22 days	29 days	36 days	43 days	54 days	13 months*
1	0.0	------	------	------	------	----	----	----	3.5
2	0.0	------	5.1	------	------	----	----	0.9	10.0
3	0.0	------	------	------	2.6	----	----	1.4	8.5
4	0.0	------	5.1	------	------	----	----	2.3	10.0
5	2.4	------	6.5	------	5.9	----	6.0	4.2	70.0
6	0.0	------	------	------	------	----	----	1.1	24.0
7	29.4	23.8	31.0	21.2	13.0	5.0	2.2	----	29.5
8	27.5	27.3	30.0	21.2	12.0	5.0	2.2	----	34.0
9	15.8	------	6.8	------	------	----	----	0.5	124.0
10	40.2	38.0	55.0	34.5	8.3	3.7	0.0	----	53.5

*Readings taken 9 months after harvesting the rice crop during which period the lysimeters had not been allowed to drain and the soil was kept saturated and fallow.

In studying the effects of adding organic matter, gypsum, lime, and sulphur on the rate of percolation in the deflocculated soil, the treatments and lysimeters were the same as given with the data in table 9. The rate of percolation was determined at the intervals indicated in table 10. The depth of the column of soil in the lysimeters was 15 inches. On account of the use of a short column of soil, which allowed too much percolation, the percolation had to be interrupted. The rates given were determined from the amount of percolation for the day preceding the date of the reading. The data show that within the first month after flooding the treatments of organic matter with lime and sulphur, organic matter with gypsum, and organic matter with sulphur were very effective in increasing the rate of percolation. There was no percolation in the check during the first two months of the experiment. After the rice crop began to head, the percolation in all the treatments reached minimum values. This was probably due partly to the absorption of water by the roots in the lower part of the column of soil. The lysimeters were not allowed to drain for 9 months after the rice crop was harvested. Then, the rate of percolation was determined over a period of a week, and it was found, as shown in table 10, that organic matter with sulphur, sulphur with lime, and organic matter with sulphur and lime were the most effective treatments used for increasing the rate of percolation. There was some percolation in the check at this time, which indicated that root channels left from the rice crop were partly effective in increasing the percolation.

Analyses were made at various dates on the percolate from the soil in the lysimeters. The effect of the treatments on exchangeable sodium was of special interest, since it had been found that the soil contained 1.25 milligram equivalents of exchangeable sodium. The buffer curve of the soil indicated that the amount of sulphur used in the experiment should be sufficient to change the reaction of the soil to pH 6.5, which was considered to be optimum, and to remove most of the exchangeable sodium. The results given in table 11 show that the percolation from the gypsum and sulphur treatments contained large amounts of soluble sodium. However, the other treatments affected the solution of sodium in about the same amounts. In general, the data show that large amounts of sodium, silica, iron, and manganese came into solution from the influence of flooding. There was no phosphorus in the percolate within the first two weeks after flooding, and only small amounts appeared at later dates. Small amounts of aluminum were found in the percolate. The different rates of drainage and the fact that the drainage was interrupted will not allow an accurate comparison of the percolation losses under the different treatments to be made.

Table 11.—Soluble constituents in the percolate from deflocculated Crowley silt loam which had been placed in 8-liter lysimeters.

Treatment	Date	Ca p. p. m.	Na p. p. m.	Fe p. p. m.	Mn p. p. m.	Al p. p. m.	SiO2 p. p. m.	P p. p. m.	Total salts p. p. m.
1		No percolate							
2	6—22	5	67	2.0	2	0.02	64	0.00	953
	8— 1	293	162	116.0	30	0.06	117	0.00	1315
3	7— 6	125	28	trace	8	0.01	61	0.00	800
	8— 1	167	160	0.4	6	0.09	64	0.33	3100
4	6—22	5	76	0.1	2	0.21	38	0.00	412
	8— 1	72	168	0.4	0	0.21	28	0.39	666
5	6—13	62	18	2.0	7	0.38	55	0.00	460
	8— 1	162	176	0.7	0	0.76	23	0.30	1200
6	8— 1	180	136	2.8	38	0.55	138	0.00	1416
7	6—13	21	22	3.1	4	0.00	66	0.00	380
	7—13	480	175	8.0	25	0.00	37	0.00	3800
8	6—13	trace	40	1.0	2	0.01	65	0.00	400
	7—13	210	170	9.0	8	0.01	40	0.11	1820
9	6—13	6	55	12.0	8	0.23	64	0.00	450
	8— 1	244	170	20.0	25	0.23	70	0.00	1860
10	6—13	trace	28	3.0	4	0.00	66	0.00	340
	7—13	240	160	7.0	7	0.00	30	0.10	1330

The relationship of intermittent drainage through the growing season to the effectiveness of organic matter and a complete fertilizer in promoting the growth of rice was studied in virgin Crowley silt loam and in deflocculated Crowley silt loam in 3-gallon pots. The soil was treated in 10-kilogram portions with organic matter and a complete commercial fertilizer. The organic matter consisted of coarsely ground soybean hay. The commercial fertilizer was an 8-8-8 mixture of ammonium sulphate, superphosphate, and muriate of potash. The fertilizer and organic matter were added singly and in combinations. The treatments were applied on April 28. Rice was planted in the pots on May 19, and on June 6 the pots were flooded with distilled water. The pots were kept in the field and exposed to the rain. Two series of the treatments on each soil were run. In one series the soil was kept flooded continuously. In the other series the pots were drained at 3-week intervals during the growing season. The treatments and their effect on the yield of rice are shown by the data in table 12. In the deflocculated soil which was drained intermittently, organic matter increased the yield 70 per cent, while the 8-8-8 fertilizer gave no increase in yield. When the deflocculated soil was flooded continuously to a depth of four inches, the organic matter gave only a 35 per cent increase, and the fertilizer raised the yield 45 per cent. Organic matter and fertilizer, when used together, were very effective under conditions of both intermittent and continuous flooding. The increases in yields were 87 and

Table 12.—Effects of treatment and intermittent drainage on yield of rice in virgin Crowley silt loam and in deflocculated Crowley silt loam in 3-gallon pots.

Treatment	Yield of grain in grams per pot	% gain or loss
Virgin soil drained every three weeks		
Check, no treatment	25.3	0.0
0.50% organic matter	29.4	16.3
600# per acre of an 8-8-8	30.0	18.7
0.50% O. M. and 600# per acre of an 8-8-8	31.9	26.2
Virgin soil flooded continuously		
Check, no treatment	21.9	0.0
0.50% organic matter	27.3	24.5
600# per acre of an 8-8-8	24.2	10.5
0.50% O. M. and 600# per acre of an 8-8-8	25.9	18.3
Deflocculated soil drained every three weeks		
Check, no treatment	9.4	0.0
0.50% organic matter	16.00	70.2
600# per acre of an 8-8-8	8.7	– 7.4
0.50% O. M. and 600# per acre of an 8-8-8	17.6	87.2
Deflocculated soil flooded continuously		
Check, no treatment	9.2	0.0
0.50% organic matter	12.4	35.0
600# per acre of an 8-8-8	13.3	44.8
0.50% O. M. and 600# per acre of an 8-8-8	17.8	93.9

94 per cent respectively. The intermittent drainage had no significant effect on the check or on the untreated deflocculated soil. Intermittent drainage increased the yields from all the treatments in the virgin soil. The increases varied from 12 to 22 per cent above the yields of the corresponding treatments in the continuously flooded virgin soil. Apparently, drainage during the growing period of rice is beneficial in a soil well supplied with active organic matter where large amounts of sulphides and soluble reduced iron and manganese may accumulate, but in a deflocculated soil which is low in organic matter and low in the available nutrients, especially nitrogen, the benefits from the removal of reduced products do not more than compensate for loss of water and nutrients through extra drainage. There were growths of algae in all the pots in the experiment and it is not known to what extent the algae may have influenced the aeration of the virgin soil. Apparently they did not influence, to any great extent, the aeration of the deflocculated soil, which had received no addition of organic matter.

DISCUSSION

The data in tables 3, 4, 7, and 8 show that the development of reducing conditions is relatively slow where the soil contains no fresh organic matter. The activity of the soil organic matter in the Sharkey soil was much greater than that of the soil organic matter in the deflocculated Crowley soil. The untreated Sharkey soil after flooding finally developed an Eh 0.07 as compared with Eh 0.04, where the soil had received fresh organic matter. In the Crowley soil to which no fresh organic matter was added, the Eh did not drop below 0.47, but in the presence of fresh organic matter the Eh was lowered from 0.63 to 0.09 within 19 days. Apparently, the development of reducing conditions depends on the rapid removal of oxygen from the soil air or from oxides in the soil. The diffusion of oxygen from the layer of water on top of the soil is too slow to be effective in maintaining any appreciable amount of oxidation in the soil. A considerable downward movement of water through the soil would be much more effective in supplying oxygen.

The accumulation of reduced products in the soil, as shown by the direct determination of sulphides and soluble iron and manganese and as shown by determination of the amount of 0.1 N potassium dichromate that a definite quantity of the soil would reduce, when compared with the changes in the Eh, shows that, in general, an inverse relationship exists between the reducing capacity and Eh. Data in tables 3 and 4 show, however, that at low Eh values there may be a relatively great increase in the amount of reduction in the soil, with little or no decrease in the oxidation-reduction potential. It was found also that there is apparently no difinite relationship between the amount of soluble iron and manganese and the total reducing capacity of the soil. The inorganic colloids probably effect changes in the oxidizing solution, and they may also effect changes in the Eh.

In determining the oxidation-reduction potentials in water-logged soils, difficulty was experienced in reading the potentiometer due to a rapid negative drift. The problem of sampling presented a great many difficulties. Variations of depth in sampling will be reflected by variations in the potential. Any manipulation which exposes the wet soil to air tends to raise the Eh. Contrary to what had been expected from the review of literature, the pH of the soil varied only slightly with the relatively large changes in Eh.

One of the most important observations made during the course of the work was that, although the addition of organic matter to the soils which were flooded markedly increased the intensity of reduction and the accumulation of soluble reduced iron and manganese, the organic matter greatly increased the yield of rice. Apparently rice is highly tolerant to soluble iron and manganese and extremely low concentrations of oxygen in the soil, as shown by the low Eh values found under the water-logged conditions. The mechanism by which decaying organic matter increases the tolerance of rice to soluble iron and manganese was not determined, but it appeared that the effect was largely through the increase of the availability of phosphorus and nitrogen and through the prevention of the precipitation of iron compounds on the roots of the rice. Apparently in a deflocculated soil where production of carbon dioxide is low and the diffusion of gases very slow, there is enough oxygen diffusing from the roots of the rice plants to cause the precipitation of oxides of iron and manganese at the root surfaces.

The data in tables 3 and 7 show that water-logging reduces the solubility of phosphorus and that the addition of organic matter to the soil tends to increase the solubility of the phosphorus.

SUMMARY AND CONCLUSIONS

The effects of water-logging and the decomposition of organic matter on the development of reducing conditions in typical rice soils have been determined and methods for improving the permeability of deflocculated soils and increasing the yield of rice on such soils have been suggested.

Development of a low oxidation-reduction potential in a water-logged soil is largely dependent on the decomposition of active organic matter in the soil. The addition of fresh organic matter to submerged soils causes a rapid lowering of the Eh. In the cases observed, where the fresh organic matter was added, the greatest intensity of reduction was developed within approximately the first three weeks, following the submergence of the soil. The lowest oxidation-reduction potentials observed varied from Eh 0.04 to 0.09. It was definitely shown in a soil in which the organic matter had been previously depleted by cropping to rice that the Eh was only lowered from 0.67 to 0.47 by water-logging in the absence of active organic matter.

In general, the oxidizing intensity as shown by Eh values and the accumulation of reduced products in the soil are inversely related, but neither can be used as an index of the ability of a submerged soil to produce rice.

Rice plants growing in a flooded soil will tolerate the presence of large amounts of soluble iron and manganese if the soil is well supplied with actively decomposing organic matter. In the absence of easily decomposable organic matter in a deflocculated soil, large amounts of iron compounds were found to be precipitated on and around the older roots of the rice plants. Presumably, this is due to the low production of carbon dioxide in the soil and to the excretion or diffusion of oxygen from the roots.

It was found that flooding the soil caused small losses of soil nitrogen by denitrification.

The solubility of phosphorus was found to be markedly lowered from the effects of the development of reducing conditions in the soil.

Applications of sulphur and gypsum in various combinations were found to be effective in increasing the permeability of deflocculated soil. However, the indications are that it would not be advisable to apply either sulphur or gypsum immediately before planting a crop of rice, for sulphides would tend to be formed in the soil after irrigation. Under the conditions where sulphides were found in the largest amounts, precipitates of sulphides occurred on the roots and reduced the yields of rice.

The application of leguminous organic matter was found to increase the yield of rice in a deflocculated soil. The use of commercial fertilizers without the addition of organic matter was not effective.

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Irish Potato Investigations

By
JULIAN C. MILLER
and
W. D. KIMBROUGH

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AGRICULTURAL EXPERIMENT STATIONS
C. T. DOWELL, *Director*

SUMMARY OF RESULTS AND RECOMMENDATIONS

1. For general planting, use 1-ounce size seed pieces, while for very early planting, use the 1.5-ounce size.
2. Space seed pieces 14 inches apart in the row.
3. Cover seed pieces 4 inches deep.
4. Apply 800 pounds per acre of 4-8-4 or 4-12-4 on a 3½-foot row basis.
5. Top-dress within two weeks after planting with 160 pounds of sulphate of ammonia, where added nitrogen is profitable.
6. Where added nitrogen is beneficial and growers do not wish to top-dress, all the nitrogen may be applied at planting time, 800 pounds of 8-8-4 or 8-12-4 being used.
7. Organic sources of nitrogen were not found to be superior to inorganic forms and usually they are more expensive.
8. Concentrated fertilizers give results that compare favorably with standard types.
9. For the amount of fertilizer generally recommended in Louisiana, the placement had little effect on yield as long as the fertilizer was available to the plant.

Irish Potato Investigations

INTRODUCTION

The results of some previous experimental work with Irish potatoes were published in Bulletin 239 of this Station. The recommendations based upon those results will be given. The fertilizer recommended was 800 pounds per acre of a 4-8-4 or 4-12-4 plus a top-dressing of 160 pounds per acre of sulphate of ammonia on a 3½-foot row basis. Sulphate of ammonia is best on soils where scab is likely to be serious, for it is an acidic fertilizer and tends toward reduction of scab injury. Concentrated fertilizers were found to compare favorably with a 4-8-4 standard. The 1-ounce to 1.5-ounce size seed pieces were best for general planting. A spacing of 14 inches was found to be most economical. Certified seed was superior to fall-grown seed.

It was thought desirable to obtain additional information concerning some of the fertilizer practices. More information seemed needed on the time of application of top-dressing. The source of nitrogen seemed to warrant further study as well as a check on the analysis of the fertilizer to apply. As concentrated fertilizers were relatively new, additional comparisons with them were thought advisable. As placement of fertilizer has been found important in some sections of the country, it was tested. The depth of planting for best results was also tried.

The procedure used in these experiments was similar to that described in Bulletin 239. Plots were located at Houma, Louisiana State University at Baton Rouge, and Alexandria. At Houma and Louisiana State University, the soils on which the experiments were conducted are known as the first bottom Mississippi alluvial soil. The soil at Houma is a mixture of Yazoo very fine sandy loam and Sharkey clay loam, while that at Louisiana State University is Sharkey fine sandy loam. These soils are known as mixed lands and are considered the best soils for potatoes in south Louisiana. The experiments at Alexandria were located on Red River Valley soil which is known as Yahola very fine sandy loam.

The Triumph variety of potatoes was used in all experiments. Rows were 3.5 feet wide, and seed pieces approximately 1 ounce in size were spaced 14 inches in the row.

Where there was doubt about the significance of difference between two treatments which were to be compared, Love's modification of "Student's Method" was used to determine the odds of significance. Odds less than 30 to 1 were not considered significant.

TIME OF APPLICATION OF TOP-DRESSING TEST

The treatments given and the results obtained are shown in table 1. Nitrate of soda was used in this test only at Louisiana State University. The nitrogen applied as top-dressing was equivalent to the 4 per cent nitrogen in the fertilizer used before planting. At Louisiana State University the data show that the application of all the fertilizer before planting was as good as the application of half before planting and half as top-dressing, while at Houma top-dressing applied within two weeks was somewhat better. At Alexandria, 8 per cent nitrogen showed no advantage over 4 per cent, nor was there any appreciable response to top-dressing there regardless of the time of application. At Louisiana State University, the application of top-dressing of both sulphate of ammonia and nitrate of soda two weeks after planting gave the highest yields. At all three places a marked response from fertilizer was obtained.

The general recommendation for the time to apply top-dressing to potatoes has been when the plants mark the row. For a time nitrate of soda was used and still is in many sections, as it is likely to be available to the plant more readily than sulphate of ammonia. It seemed that sulphate of ammonia should be applied before plants marked the row. The results show that this is true for nitrate of soda as well as suphate of ammonia. Some growers object to applying a top-dressing, and, if no top-dressing is to be applied, all of the nitrogen may be applied before planting. This is especially true where forms of nitrogen which do not leach badly are used. The main disadvantage of applying all the nitrogen before planting is its probable leaching before being utilized by the plant. The advantage of applying part of the nitrogen as a top-dressing is that heavy rains may fall before the top-dressing is applied, and if part of the nitrogen has been saved as top-dressing, it will not be lost through these heavy rains. As the top-dressing leaches down through the soil it must pass by the plant roots, which are present before the sprouts emerge from the surface, and in this way it can be easily utilized.

There are some disadvantages of top-dressing, however. Due to heavy rains it may not be possible to get in the field at the time the top-dressing should be applied. This is one reason for not waiting until plants mark the row before applying the top-dressing. At times, no rain falls after the top-dressing is applied until it is too late for the plant to get much or any benefit from the added nitrogen, and in such cases it is wasted so far as the potato crop is concerned. If the surface of the ground is not broken before or immediately after the top-dressing is applied, much of the nitrogen may be washed off ridged rows, such as are used in Louisiana, and may thus be lost to the crop. It must be realized, then, that adding all the nitrogen before planting and a portion as top-dressing have both advantages and disadvantages. Leaching of nitrogen is a more serious problem on lighter soils than it is on heavier ones. Where the application of a top-dressing does not give economical increases in yield, it is obviously unnecessary to add it.

SOURCE OF NITROGEN TEST

In this test fertilizer was applied at the rate of 800 pounds per acre. The plots receiving nitrogen received 8-12-4 before planting and the "no nitrogen" plots received 0-12-4. The same treatments were given at Houma and Louisiana State University, but the treatments at Alexandria were varied somewhat to more thoroughly test cottonseed meal in that section where it is generally used and to omit shrimp meal which is not important there. The organic sources of nitrogen tested were cottonseed meal and shrimp meal, and sulphate of ammonia and nitrate of soda were used as inorganic sources. These sources were applied separately and in various combinations. Treatments given and results obtained are shown in tables 2 and 3. No top-dressing was given except where indicated.

The results show that there was a response to nitrogen at all three places of trial. There was not a great deal of difference in yield due to the source of nitrogen. While the yields varied to some extent, there was no one source or mixture that was markedly superior to the other. There was in general no response to the top-dressing which some plots received. So far as yield alone is concerned, the source of nitrogen did not seem important. The cost then would be an important factor. Organic sources are usually higher than inorganic and the latter sources

TABLE I. DATE OF APPLICATION OF TOP-DRESSING EXPERIMENT

Yields in Bushels Per Acre

	HOUMA			LOUISIANA STATE UNIVERSITY						ALEXANDRIA		
	Sulphate of Ammonia			Sulphate of Ammonia			Nitrate of Soda			Sulphate of Ammonia		
Treatment*	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
8-12-4	235.7	21.1	6.2	261.7	32.6	8.5	230.1	27.0	6.1	163.2	24.6	9.5
4-12-4 Top-dressed day of planting	248.2	20.5	5.5	254.6	30.2	6.7	248.8	29.6	7.8	172.8	27.8	8.5
4-12-4 Top-dressed 2 weeks after planting	247.1	19.6	4.6	267.9	29.0	6.8	259.2	27.3	7.0	171.6	23.6	8.0
4-12-4 Top-dressed when plants marked the row	216.9	21.4	4.9	254.6	26.2	7.0	242.6	30.1	7.6	178.9	25.6	8.9
4-12-4 Top-dressed 2 weeks after plants marked the row	214.5	22.2	4.8	244.1	28.3	5.9	241.1	24.5	6.2	167.3	22.3	7.3
4-12-4 No Top-dressing	218.3	21.9	5.7	216.4	26.7	9.6	200.8	24.5	6.2	167.0	28.3	8.5
Check—No Fertilizer	162.9	22.6	4.8	145.2	30.9	5.5	130.3	25.6	4.9	117.2	21.5	6.7

* Fertilizer applied at the rate of 800 pounds per acre. Top-dressing 160 pounds per acre of sulphate of ammonia or equivalent.

have proved to be good for Irish potatoes. As nitrate of soda may leach more readily than sulphate of ammonia and as it may tend to increase scab infestation, sulphate of ammonia is generally recommended in Louisiana on soils which are not not likely to be made too acid by its application. The Irish potato as grown in Louisiana is a short season crop and should be kept growing rapidly if the best results are to be obtained. Enough nitrogen must be present to keep the plants growing as they should. If too much nitrogen is present, maturity of the crop may be delayed to some extent.

TABLE II. SOURCE OF NITROGEN TEST

Yields in Bushels Per Acre—2-Year Average

Treatment* Source of N	HOUMA No. 1	HOUMA No. 2	HOUMA No. 3	L. S. U. No. 1	L. S. U. No. 2	L. S. U. No. 3
Cottonseed Meal	218.6	21.2	5.5	178.7	35.2	11.9
¾ CSM—¼ Sulphate of Ammonia	214.7	19.1	5.9	168.0	36.7	12.7
¾ CSM—¼ Nitrate of Soda	213.4	22.2	6.3	154.7	32.1	10.2
½ CSM—½ Sulphate of Ammonia	210.3	22.5	6.9	154.2	38.1	11.9
½ CSM—½ Nitrate of Soda	199.5	20.7	5.2	169.8	22.4	12.3
Check (PK)	171.0	22.7	5.2	89.4	24.4	5.7
CSM+Top-dressing	199.5	21.9	7.7	174.3	31.9	9.3
Sulphate of Ammonia	212.7	22.0	7.0	158.8	36.4	11.5
¾ Sulphate of Ammonia—¼ Nitrate of Soda	212.5	18.9	5.5	145.4	33.7	10.8
½ Sulphate of Ammonia—½ Nitrate of Soda	212.3	22.5	5.5	159.2	35.6	12.2
¼ Sulphate of Ammonia—¾ Nitrate of Soda	206.5	22.4	5.8	139.8	35.4	9.5
Check (PK)	184.8	20.3	6.0	81.2	23.7	6.1
Nitrate of Soda	201.4	21.1	5.0	149.9	35.9	10.4
Shrimp Meal	211.5	17.0	6.6	134.1	31.5	10.0
¾ SM—¼ Sulphate of Ammonia	210.7	19.8	6.0	141.2	34.1	11.4
½ SM—½ Sulphate of Ammonia	213.1	20.1	5.9	147.0	36.6	9.9
SM+Top-dressing	203.8	20.5	6.2	171.8	32.2	5.5
Check (PK)	178.5	17.5	7.6	88.2	22.6	6.7

* All plots received 800 pounds of 8-12-4 except check plots which received 800 pounds of 0-12-4. When top-dressings were added, 160 pounds per acre of sulphate of ammonia were used.

TABLE III. SOURCE OF NITROGEN TEST AT ALEXANDRIA

Yields in Bushels Per Acre—3-Year Average

Treatment* Source of N	No. 1	No. 2	No. 3
Cottonseed Meal	144.1	21.7	7.8
¾ CSM—¼ Sulphate of Ammonia	141.3	23.0	7.6
¾ CSM—¼ Nitrate of Soda	142.4	22.6	8.5
½ CSM—½ Sulphate of Ammonia	138.7	23.2	8.9
½ CSM—½ Nitrate of Soda	154.6	25.3	8.2
PK (No N)	115.5	21.7	8.3
Check (No Fertilizer)	112.1	24.4	7.0
CSM+Top-dressing	143.4	21.9	6.6
CSM (600 lbs. per acre no other PK)	149.5	20.8	6.6
CSM (600 lbs. per acre no other PK)+Top-dressing	144.3	20.7	7.6
Sulphate of Ammonia	174.5	27.8	10.5
PK (No N)	112.1	20.9	8.1
Check (No Fertilizer)	107.5	22.4	6.7
¾ Sulphate of Ammonia—¼ Nitrate of Soda	157.1	24.5	9.6
½ Sulphate of Ammonia—½ Nitrate of Soda	176.0	23.2	8.6
¼ Sulphate of Ammonia—¾ Nitrate of Soda	153.4	26.6	7.2
Nitrate of Soda	142.7	21.4	8.5
PK (No N)	118.0	22.4	7.8

* All plots received 800 pounds of 8-12-4 unless otherwise noted. PK plots received 800 pounds of 0-12-4. Where noted, top-dressing was applied at the rate of 160 pounds per acre of sulphate of ammonia.

SPECIAL FERTILIZER TEST

In order to further investigate some of the results of fertilizer tests reported in Louisiana Experiment Station Bulletin 239, this test was run. The treatments given and results obtained are shown in table 4. At Houma and Louisiana State University there was little difference between the 4-12-4 plus top-dressing and the 4-8-4 plus top-dressing, and best yields were obtained with these treatments. At Alexandria there was little difference between any of the treatments which received fertilizer before planting. Two per cent nitrogen plus top-dressing was sufficient, but other tests at Alexandria showed that 4 per cent nitrogen in an 800-pound application was sufficient. The 8 per cent phosphoric acid was as good as 12 per cent and no response was obtained from potash. The top-dressed checks gave increased yields in all cases, showing the response to nitrogen applied at that time.

CONCENTRATED FERTILIZER TEST

As concentrated fertilizers were comparatively new, it was thought best to continue some work with them. In previous tests no top-dressings were applied but in this test all plots received a top-dressing at the rate of 160 pounds per acre

TABLE IV. SPECIAL FERTILIZER TEST

Yield in Bushels Per Acre—3-Year Average

Treatment	HOUMA No. 1	HOUMA No. 2	HOUMA No. 3	L. S. U. No. 1	L. S. U. No. 2	L. S. U. No. 3	ALEXANDRIA No. 1	ALEXANDRIA No. 2	ALEXANDRIA No. 3
2-12-4 800 lbs. per acre 160 lbs. sulphate of ammonia top-dressing	233.9	22.5	6.6	210.8	24.0	5.5	175.7	23.3	7.3
4-12-4 800 lbs. per acre 160 lbs. sulphate of ammonia top-dressing	254.8	20.6	5.9	229.3	25.0	6.7	173.5	23.3	8.1
4-8-4 800 lbs. per acre 160 lbs. sulphate of ammonia top-dressing	247.2	20.1	6.3	230.9	27.8	6.9	173.9	21.7	8.3
4-8-0 800 lbs. per acre 160 lbs. sulphate of ammonia top-dressing	222.2	20.1	4.6	226.8	28.2	5.8	172.9	24.6	7.6
0-0-0 160 lbs. sulphate of ammonia top-dressing	219.2	19.9	7.3	161.1	24.0	5.0	132.5	21.0	8.0
0-0-0	175.0	20.0	5.7	112.5	21.6	4.8	116.8	26.2	7.3

of sulphate of ammonia. Some of the concentrated fertilizers had to be dropped from the test because of their removal from the market. The treatments given in this test and the results obtained are in table 5. The yields obtained were very uniform for fertilizer results and indicate that all fertilizer treatments were equally effective. The data show that the yields obtained where concentrated fertilizers were used compare favorably with 4-12-4 as a standard. The increased yield following the increase in the amount of 12-24-12 applied was not appreciable. This indicated that under the conditions of this experiment, the extra fertilizer was not utilized to advantage.

TABLE V. CONCENTRATED FERTILIZER TEST

Yields in Bushels Per Acre—3-Year Average

	HOUMA			L. S. U.			ALEXANDRIA		
Treatment*	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No.1	No.2	No.3
Ammophoska 10-30-10 320 lbs. per acre	224.8	23.6	6.5	165.1	39.6	11.3	169.4	26.3	10.1
Nitrophoska 12-24-12 267 lbs. per acre	227.7	22.8	7.2	159.0	32.5	11.8	162.7	25.3	8.9
Nitrophoska 12-24-12 400 lbs. per acre	228.7	20.3	6.1	167.6	38.3	12.9	164.0	24.8	10.7
4-12-4 800 lbs. per acre	235.5	19.2	5.3	165.8	36.9	13.0	171.6	25.0	11.1

* All plots received a top-dressing of 160 lbs. per acre of sulphate of ammonia when plants marked the row.

PLACEMENT OF FERTILIZER

The placement of fertilizer is receiving considerable attention at the present time. In some sections of the country, placing the fertilizer in bands on each side of the seed pieces of Irish potatoes has proved to be the best method of application. The treatments given and the yields obtained are shown in table 6. The only treatment that may need some explanation is the band on top. In this case the seed pieces were covered with a shallow layer of soil, the fertilizer was applied, and the row was then covered and ridged as were other rows. Variations in yield were not marked. At Houma there was no appreciable difference, with the possible exception of the band on the bottom of the row where the lowest yield was obtained. At Louisiana State University there was no marked difference except that the yield from the band on top treatment was slightly higher. At Alexandria the band on one or both sides and on top treatments gave somewhat higher yields than the other two treatments. In general, the method of application of fertilizer did not appreciably affect yields obtained. An explanation for this may lie in the rate of fertilizer applied. The placement of 800 pounds per acre recommended in Louisiana does not appear of primary importance as long as the fertilizer is placed within reach of the growing plants. When new planters are bought, however, it is suggested that the ones that place the fertilizer in bands on both sides of the seed pieces be obtained, as these might have some advantages under certain conditions over those that put a band in the bottom of the furrow.

DEPTH OF PLANTING TEST

The planting depths and yields obtained are given in table 7. The planting depth of four inches is best when all three places are considered. The next best depth tried was five inches. With the shallower plantings, larger yields of No. 2 and No. 3 potatoes were obtained.

TABLE VI. PLACEMENT OF FERTILIZER TEST

Yields in Bushels Per Acre—3-Year Average

	HOUMA			L. S. U.			ALEXANDRIA		
Treatment*	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
Mixed in furrow	223.6	17.4	4.8	213.4	21.5	4.1	164.7	24.2	8.5
Band in bottom of furrow	208.7	20.0	8.3	207.4	20.3	3.5	164.5	21.6	8.3
Band on one side	220.7	22.2	7.2	210.9	19.2	4.1	179.1	22.1	7.5
Band on both sides	222.8	20.4	7.5	216.5	19.0	3.2	181.1	26.7	8.1
Band on top	217.7	19.0	7.2	231.6	22.9	4.5	184.4	24.6	9.7

* All plots received 800 lbs. per acre of 4-12-4 and were top-dressed with 160 lbs. per acre of sulphate of ammonia.

TABLE VII. DEPTH OF PLANTING TEST

Yields in Bushels Per Acre—3-Year Average

	HOUMA			L. S. U.			ALEXANDRIA		
Treatment*	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
2 inches	165.0	26.7	15.6	147.6	53.0	24.1	164.5	33.2	16.2
3 inches	182.8	29.9	11.8	160.1	43.8	18.1	168.9	32.8	14.2
4 inches	210.1	24.8	8.7	164.4	43.2	16.7	219.0	23.8	10.5
5 inches	207.0	19.8	6.4	170.7	36.4	12.6	172.9	20.8	8.3

* All plots received 800 lbs. per acre of 4-12-4 and were top-dressed with 160 lbs. per acre of sulphate of ammonia.

DISCUSSION

The cultural experiments conducted for the last six years form a basis for recommendations which, if followed by the potato growers of Louisiana, should give good results. Fertilizer treatment has received special attention. The response from fertilizer will depend to a large extent on the soil and its condition. Heavy applications of fertilizer would not be profitable on very poor land that is in poor physical state or on poorly drained land. Under these conditions other things besides plant nutrients are the factors that limit growth. In very dry years or when an early attack of some disease causes early maturity of the potato crop, full benefits cannot be expected from fertilizer applied. The increase in yield from fertilizer will depend upon the deficiency in the soil of the nutrients applied, if other things are not serious limiting factors. On good land which contains considerable organic matter and which has been cultivated for a number of years and fertilized with heavy applications of complete fertilizer, nitrogen may be the only element commonly added that will give a response. This seemed to be true on some of the plots at Houma. There was no consistent response to potash, but it often proved beneficial. If it is known that potash will give no response and if home-mixed fertilizer is used, it may be left out for a time at least. In general it is believed that it is best to use a complete fertilizer. The recommended fertilizer to use is 800 pounds per acre of 4-12-4 or 4-8-4. In general this should be supplemented with 160 pounds of sulphate of ammonia applied as a top-dressing within two weeks after planting. Growers who object to applying top-dressing may obtain about as good results by using 800 pounds per acre of 8-8-4 or 8-12-4. If this is done, it is best to use a source of nitrogen that does not leach readily. Inorganic forms of nitrogen have proved to be as good sources as organic forms and are usually more economical. Concentrated fertilizers have given results that compare favorably with standard types.

In order that the recommended fertilizer rate may be easily determined for varying row widths, table 8 is given.

If home mixing of fertilizer is practiced, the following suggestions will probably be beneficial.

Suggestions for home mixing of fertilizers analyzing 4-12-4 and 4-8-4:-

Amounts of materials to use to make a ton:

4% Nitrogen—Use one of the following:		
Sulphate of ammonia (20% N)	400 lbs.	(acid reaction)
Nitrate of soda (16% N)	500 lbs.	(alkaline reaction)
Sulphate of ammonia (20% N)	120 lbs.	(neutral reaction)
Nitrate of soda (16% N)	350 lbs.	(neutral reaction)
12% Phosphoric acid		
Superphosphate (20% P_2O_5)	1200 lbs.	
8% Phosphoric acid		
Superphosphate (20% P_2O_5)	800 lbs.	
4% Potash		
Muriate of potash (50% K_2O)	160 lbs.	

When mixed in the proportions given, the total does not weigh a ton and filler must be added to make an actual ton. Adding filler is not necessary, however, as long as the right proportion of the mixture is added per acre; that is, if the equivalent of 800 pounds of 4-12-4 is desired, just apply at the rate of two-fifths of mixture used in making the equivalent of a ton. For example, if a 4-12-4 is made from sulphate of ammonia, superphosphate, and muriate of potash, the resulting mixture would weigh 1760 pounds. Two-fifths of this, or 704 pounds per acre, is equivalent to 800 pounds of 4-12-4.

One to 1.5-ounce size seed pieces are recommended, the larger size being better for early planting and the smaller for general planting. So that the grower may easily determine the amount of seed potatoes needed for a given area, table 9 is included.

TABLE VIII. FERTILIZER TO APPLY FOR POTATOES WHEN PLANTED AT VARIOUS ROW WIDTHS*

Width of row in feet	Rate per acre in pounds
3½	800
4	700
4½	622
5	564
5½	509
6	467
6½	431
7	400

* Apply 6.43 lbs. per hundred feet of row.

TOP-DRESS

Width of row in feet	Ammonium Sulphate	Nitrate of Soda
3½	160	200
4	140	175
4½	124	155
5	113	140
5½	102	127
6	93	117
6½	86	108
7	80	100
	* Apply 1.3 lbs. per hundred feet of row	* Apply 1.6 lbs. per hundred feet of row

A planting distance of 14 inches has given best results.

Placement of fertilizer was not found to be important at the rate recommended in this state. Care in placement would most likely be necessary where heavier applications are made. Placement in bands on both sides of the seed pieces is generally recognized as the best procedure.

A planting depth of four inches was best.

TABLE IX. NUMBER OF BUSHELS OF POTATOES REQUIRED TO PLANT AN ACRE AT DIFFERENT SPACINGS WITH SEED PIECES OF 1- AND 1.5-oz. SIZES

Spacing in the row		12 inches				14 inches				16 inches			
Size of piece	Width of row in feet:	3.5	4	4.5	5.5	3.5	4	4.5	5.5	3.5	4	4.5	5.5
1 oz.		13 bu.	11.3	10.1	8.3	11.1	9.7	8.6	7.1	9.7	8.5	7.6	6.0
1.5 oz.		19	16.9	15.0	12.3	16.6	14.6	12.9	10.6	14.5	12.7	11.4	9.0

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Diseases of Sugar Beets in Louisiana

By

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Diseases of Sugar Beets in Louisiana

C. W. EDGERTON AND E. C. TIMS

Experimental trials with sugar beets have been carried on at a number of different times in Louisiana during the past fifty years. If it were possible to grow sugar beets in the state commercially, it would mean considerable to those interested in sugar production. It would mean that the sugar factories, most of which are now in operation only about two and a half to three months during the year, could be utilized over much longer periods. The production of sugar beets then would not only be profitable to those who could grow another crop but would be of material benefit in cutting down the large overhead costs of the mills. As further attempts will undoubtedly be made to grow sugar beets, it seems advisable at this time to make a record of some of the results obtained at earlier periods and to state the reasons why these earlier attempts failed or were unsatisfactory.

The idea of growing sugar beets in order that the sugar factories might be kept in operation for a greater part of the year apparently originated with Dr. W. C. Stubbs, first director of the Louisiana Agricultural Experiment Station in about 1886. From that date until about 1910, experimental plots of sugar beets were planted from time to time in the Experiment Station fields. It was during this period that the sugarcane industry was the most prosperous and there was no special need of a supplementary crop. No attempts were made to grow the beets on a commercial scale.

There was a revival in interest in sugar beet growing about 1920. From that date until 1924, beets were grown on the Experiment Station Farm at Baton Rouge by Dr. C. E. Coates and A. F. Kidder (4). Some fairly satisfactory results were obtained, but these tests were not grown on a commercial scale and little attention was paid to the occurrence of diseases. From notes on file in the Department of Plant Pathology, Louisiana Agricultural Experiment Station, it is known that some of these plots showed as high as a 50 percent infection with one of the important diseases. This large percentage would have been a very serious matter if it had been necessary to ship the beets to a sugar house.

In 1925, as a result of the failure of the sugarcane crop, interest in beet growing became more general. Sugar beet machinery was installed in the sugar factory at the Experiment Station at Baton Rouge. In the fall and winter of 1925-1926, plantings of beets were made at a number of points in the cane belt. Altogether, on twenty-nine different plantations in fifteen parishes, about one hundred acres of beets were grown in blocks of from one to seven acres. In 1926 the yields from the larger plantings which were harvested in May and June (2) were quite disappointing when compared with the previous yields from small plots. Yields from most of the plots were less than five tons per acre. However, there were several reasons for the low production, among them being (a) improper soil preparation and deficient drainage, (b) an excessively heavy rainfall during the early months of 1926 (the rainfall in southwestern Louisiana in January, February, and March was the heaviest in the history of the Weather Bureau, being about twenty-five inches as compared to a normal of around fourteen inches), combined with low temperatures, and (c) the occurrence of two very destructive rot diseases. The losses from these two diseases ranged from 40 to 100 percent, with an average of about 70 percent.

In 1927, about two hundred acres of beets were grown. The early plantings were practically all killed by a freeze in early January, and it was necessary to replant. In order to reduce the loss from rot, the beets were rushed to the mill during the first few days in May before the temperature had become high. There was considerably less loss at the factory as a result. As usual, beets that were left in the field during the latter part of May and the first part of June rotted very severely.

After 1927, the beet work was continued for a few years on a small scale by the Experiment Station but was discontinued by the growers throughout the state. The abandonment of the tests was due to two things: (1) the new cane varieties which had been introduced in the state were making good yields and a supplementary crop was not necessary. (2) The diseases caused such heavy losses that it seemed impossible to grow sugar beets on a commercial scale until satisfactory control measures could be worked out.

The disease problems connected with the growing of sugar beets in a warm, subtropical region should be of interest and should be carefully considered in future attempts to grow beets commercially in Louisiana. This report presents a summary of the observations and the studies which have been made in Louisiana, especially between 1926 and 1928, on the serious diseases of sugar beets.

DISEASES OCCURRING IN LOUISIANA

Several diseases of economic importance or special interest occur in Louisiana. These include two diseases which rot the beet itself, two leaf diseases, and the gall disease of the root.

The two rot diseases are the Rhizoctonia rot, dry rot canker or winter rot, caused by the fungus, *Rhizoctonia* sp., and the Sclerotium or summer rot, caused by *Sclerotium rolfsii.* The two diseases are rather easy to distinguish by their symptoms and by the fact that the Rhizoctonia disease appears in the cool winter and spring, while the Sclerotium rot occurs only in warm weather. There is some overlapping of the two diseases in April and May, but in general the Rhizoctonia disease decreases with the approach of warm weather, while the Sclerotium injury increases. These two diseases were responsible for the crop failures in 1926 and 1927 and are apparenty the most important limiting factors in sugar beet production in Louisiana.

Of the two leaf diseases, the common leaf spot caused by the fungus, *Cercospora beticola,* can become very destructive in warm weather. The other, the large leaf spot caused by the fungus, *Phoma betae,* is apparently only of minor importance.

The gall disease caused by the nematode, *Coconema radicicola,* will doubtless become very important if the beet industry is attempted in sandy regions of the state.

I. Rhizoctonia Rot

The early symptoms of the Rhizoctonia rot of beets, as the disease develops in Louisiana, are similar to those mentioned by various investigators from other sections of the country. There is first a blackening of the petioles of the outer leaves on half-grown plants. The affected tissues die and the petioles collapse, this often taking place while the leaves are still green. As the fungus spreads, the whole crown gradually becomes affected. When the disease is severe, the tops of all plants on large areas will be killed. With favorable weather conditions, plants which are not seriously rotted may put out new leaves and make some growth even after the tops are killed. Typical diseased plants are shown in figure 1.

In another stage of the disease, definite brown lesions quite irregular in shape and size develop on the beet. While these are common near the crown region, many also occur below the soil line. In the older beets (fig. 1-A) large cracks containing heavy, brown mycelial mats are commonly present. These are quite similar to the dry rot canker stage of the disease which occurs in most of the beet sections of the country. The principal injury to the beet caused by Rhizoctonia rot is the rotting of the leaves and crown. The presence of this disease on beets did not cause any trouble at the mill.

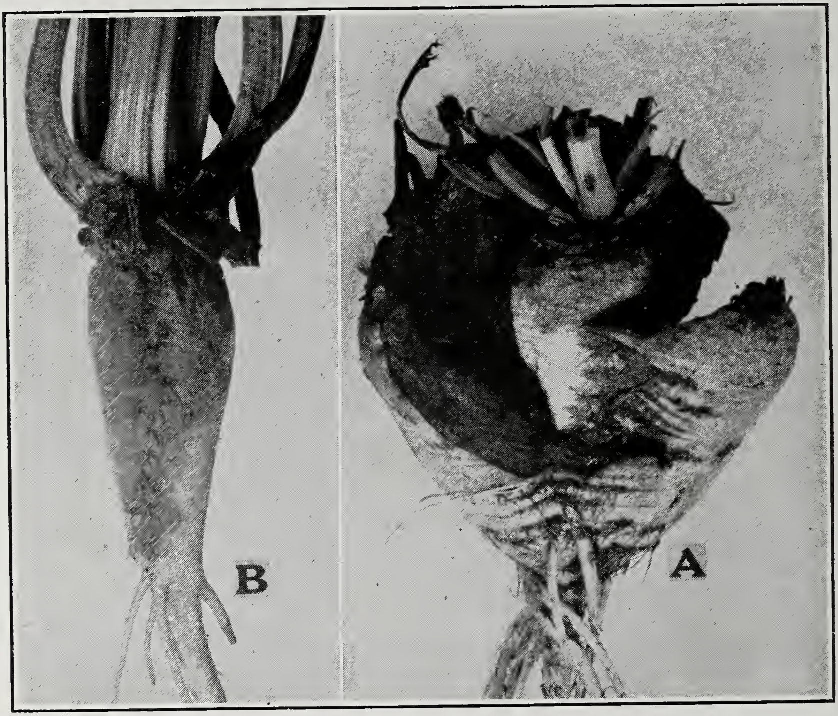

FIGURE 1.—Rhizoctonia rot on sugar beets. A. Early stages of the rot showing irregular shaped brown areas on the beets. B. Typical cracking of beets characteristic of older stages of the rot.

The Rhizoctonia rot has been very destructive in fields where conditions have been favorable for its development. In the late winter and early spring of 1926, following long periods with excessive rains, losses from this trouble were very severe. In one field, 55 percent of the beets were found affected and the loss was at least 35 percent. In most of the fields, the infection varied from a trace to 25 or 30 percent. The disease was present in practically all of the beet fields in the southwestern part of the state. Most of the loss occurred in the winter and early spring. During the dry weather which occurred later in May and June, the disease symptoms practically disappeared. In the season of 1927, due to more favorable weather conditions, the disease was much less severe, though fields showing from 5 to 10 percent infection were observed. Losses from this disease can always be expected when the soil becomes saturated and stays so for some time as a result of heavy and frequent rains.

II. SCLEROTIUM ROT

The fungus, *Sclerotium rolfsii,* is largely confined to the warmer tropical and subtropical regions of the world. Where conditions are favorable, it attacks a wide range of plants causing wilts and rots. On sugar beets in this country, the fungus was apparently first reported from California in 1919 (9). In Louisiana, Edgerton (10) reported a "50 percent loss in some patches of sugar beets" in 1922. These were the small test plots being grown by Coates and Kidder on the Experiment Station Farm. The disease also occurs in Oriental countries on sugar beets. Nakato in 1922 (8) found the fungus widespread over Korea, and later in 1925 he (7) reported that sugar beets in Japan were severely affected by root rot caused by *Sclerotium rolfsii.*

In recent years, the disease has assumed considerable economic importance in some of the principal beet sections in southern California (6).

In Louisiana, beets affected with *Sclerotium rolfsii* usually show a yellowing and wilting of the outer leaves followed, when conditions are favorable, by a sudden wilting and collapsing of all the leaves. There is none of the blackening of the leaf bases which is characteristic of the Rhizoctonia disease. When all the leaves collapse, the crown is usually involved in the rather soft, greyish rot. Beets in this condition never recover. Infection begins near the soil line and spreads rapidly over the exposed surface of the beet. Below the soil line the rot develops slowly, and only in advanced stages does it reach the bases of the roots. Under favorable conditions, the brown sclerotia, which resemble mustard seed, form on the surface of the beet at or above the soil line. A decaying beet with sclerotia and mycelium on the surface is shown in figure 2.

In 1926, the Sclerotium rot was observed in varying amounts in all of the seventeen parishes in which beets were grown. The severity of the rot varied from only a trace in a very few fields to as high as 75 percent in one field. The rot became much more severe as the temperature rose in the late spring, and in most of the fields that were not dug until after the temperature became high the beets rotted so severely that they were worthless for milling.

In spite of extreme care in eliminating diseased beets in the field, a certain number will be loaded in the cars with the healthy beets and sent to the mill. If the weather is warm and there is sufficient moisture on the beets, the rot will spread rapidly throughout the car. During the 1926 campaign many cars reached the mill in very bad condition. One car containing eighteen tons of beets was practically destroyed by the rot fungus during the four days that elapsed between loading and arrival at the factory (fig. 3). The beets were almost completely covered with the white mycelium of the fungus and there were very few sound ones in the entire car. While most of the beets were injured only superficially, the rot extending from a quarter to a half inch in depth, they could not be milled because of the effect of the rotted areas on the juice. Mill operators found that a few partially decayed beets lowered the purity of the juice to a point where sugar making was very difficult.

Analyses (2) of beets moderately affected with Sclerotium rot showed a sucrose of 4.99 percent and a purity of 42, while healthy beets showed a sucrose of 14.67

percent and a purity of 83. Brewster and Webre (3) found that "rotted beets slice badly, giving ragged, soft cossettes; the juice becomes dark and the quantity of lime salts rises."

CONTROL EXPERIMENTS

The possibility of controlling the Sclerotium rot disease was considered while the other investigations were being carried on. Tests were conducted with lime and various fertilizers, and attention was paid to the possible resistance of many varieties.

The fungus, *Sclerotium rolfsii,* responds peculiarly under acid and alkali conditions. It will not begin growth in a medium that is alkaline, but if it obtains a start it can acidify the medium in which it is growing in advance of the mycelium. There was a possibility that lime might be beneficial in controlling the disease in the field if enough could be applied to stop the growth of the mycelium. Lime was used in three different ways: (1) applied to the soil in which beets were to be grown, (2) mixed with the beets in the cars at the time of shipping to the mill, and (3) applied to beets placed in storage.

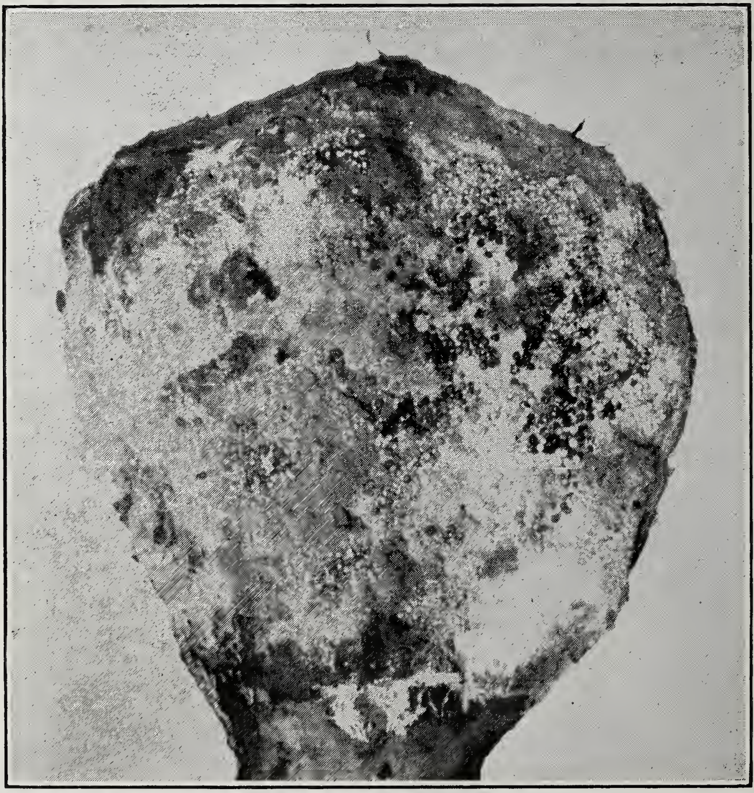

FIGURE 2.—Sugar beet showing sclerotia and mycelium of *Sclerotium rolfsii.* Taken from a car of badly decayed beets.

EFFECT OF LIME APPLIED TO THE SOIL

Tests with lime were conducted in the field at the Experiment Station at Baton Rouge, Louisiana, in 1928 and 1929.* Lime was applied to a loam soil at the rate of two and four tons per acre.

Beets grown in 1928 and 1929 were rotted quite as severely in the plats treated with lime as in those receiving no lime, indicating that lime up to four tons per acre does not make soil of this type basic enough to stop the growth of the fungus.

EFFECT OF LIME APPLIED TO BEETS IN TRANSIT AND STORAGE

Finding that beets rotted quite severely when kept in the cars for two to five days while in transit or waiting at the factory, attempts were made to reduce the amount of decay by applying lime to the beets as they were loaded. As the beets were unloaded from the wagons into the cars, a workman spread lime over them as uniformly as possible at the rate of about twenty to twenty-five pounds per ton of beets. While it was

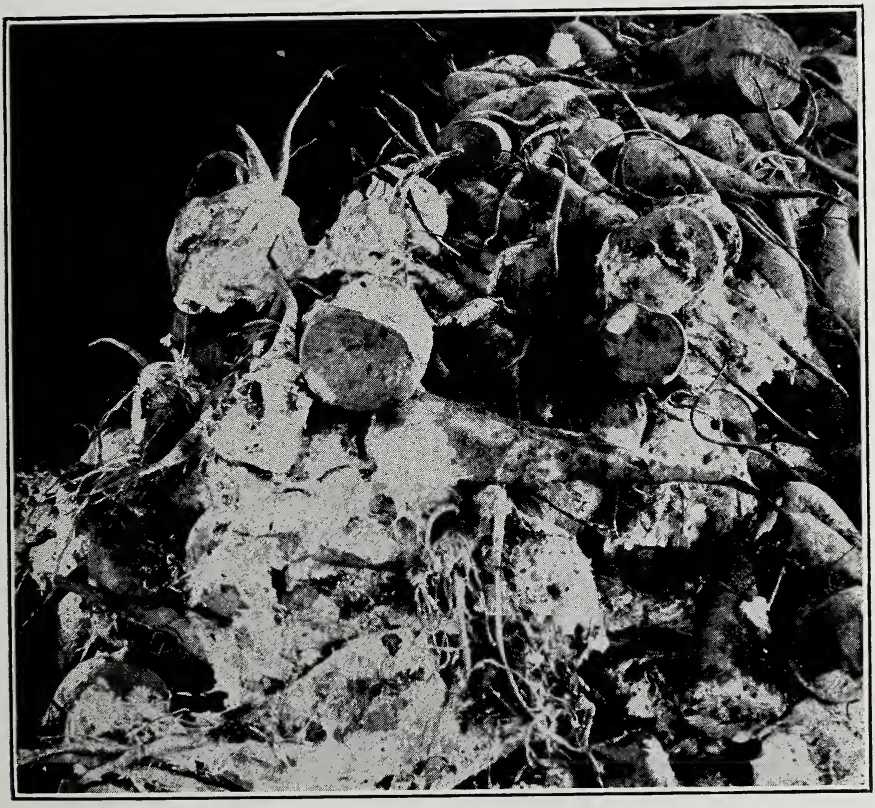

FIGURE 3.—Beets covered with white mycelium of *Sclerotium rolfsii.* Taken inside a car of beets upon arrival at the factory.

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* These tests were started by D. N. Barrow and continued by Dr. H. B. Brown.

impossible to have suitable controls and to handle the work in an experimental manner, observations indicated that lime reduced the spread of the rot to some extent. The cars to which lime was applied had smaller percentages of rotten beets than other cars in which no lime was used.

A test was also made to determine the effect of lime in reducing the spread of rot in stored beets. Beets were taken from the field, placed in wooden boxes, and inoculated by means of a diseased beet. In two of the boxes lime was spread over the beets as uniformly as possible at the rate of ten and twenty pounds to the ton, respectively, while the third box was left untreated. The boxes were covered with burlap sacks and a ten-quart pail of water applied to each box. They were then placed under a shed out of the sun and examined after ten days. Lime at the rate of twenty pounds per ton of beets greatly reduced the amount of rot as compared to the controls with no lime.

EFFECT OF FERTILIZERS

In connection with general fertilizer tests* conducted by the Department of Agronomy over a period of three years, data were recorded on the effect of fertilizers on the Sclerotium rot of beets. In the 1926 and 1927 tests twenty-six fertilizer combinations were used in triplicate plots. At time of harvest all the beets were examined for Sclerotium rot. In the 1926 tests, the percentage of rot varied from 5 to as high as 50 percent, but there were no consistent, clear-cut differences in the various fertilizer treatments. The tests of 1927 were very similar except that the amount of rot was much less than in the previous season. In the 1929 fertilizer tests the rot percentages varied from 19 to 46 percent, with no distinct differences in the plots receiving the various fertilizer combinations.

THE COMMON LEAF SPOT DISEASE

The common leaf spot disease, caused by the fungus, *Cercospora beticola,* is apparently present everywhere that beets are grown. On the leaves are small, light-colored spots with darker borders. Hundreds of these spots may be present on a single leaf, and when they become numerous the leaf turns yellow and gradually dies. When the disease is severe the leaves begin to die by the time they are fully developed and the plants consequently show just a few green leaves at the top. In Louisiana, the disease is usually not important during the cool weather but often spreads very rapidly as spring approaches. Fields were observed in which the plants were practically killed by the disease. If attempts are made to grow beets during the warmer weather, this disease will have to be considered.

LARGE LEAF SPOT

The large leaf spot caused by the fungus, *Phoma betae,* was found to a limited extent in Louisiana. This disease is characterized by large spots or dead areas on the leaf.

The large leaf spot disease is of interest because in the past it has been associated with a peculiar rot of the beet. In a recent publication, Kotila and Coons (5) claim that this rot is due to a deficiency of boron in the soil. This possibly explains why this type of rot has not accompanied the disease in Louisiana. It seems evident that the Louisiana soils have sufficient boron present.

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* The fertilizer experiments were begun by D. N. Barrow and continued by Dr. H. B. Brown.

NEMATODE ROOT GALLS

Galls on the beets and smaller roots, produced by the nematode, *Coconema radicicola,* occur very commonly in the sandy soils in warm weather. These galls check the development of the beets. As nematodes attack a great many different plants, it is a very serious matter to have the soils become infested with them. If beets are to be

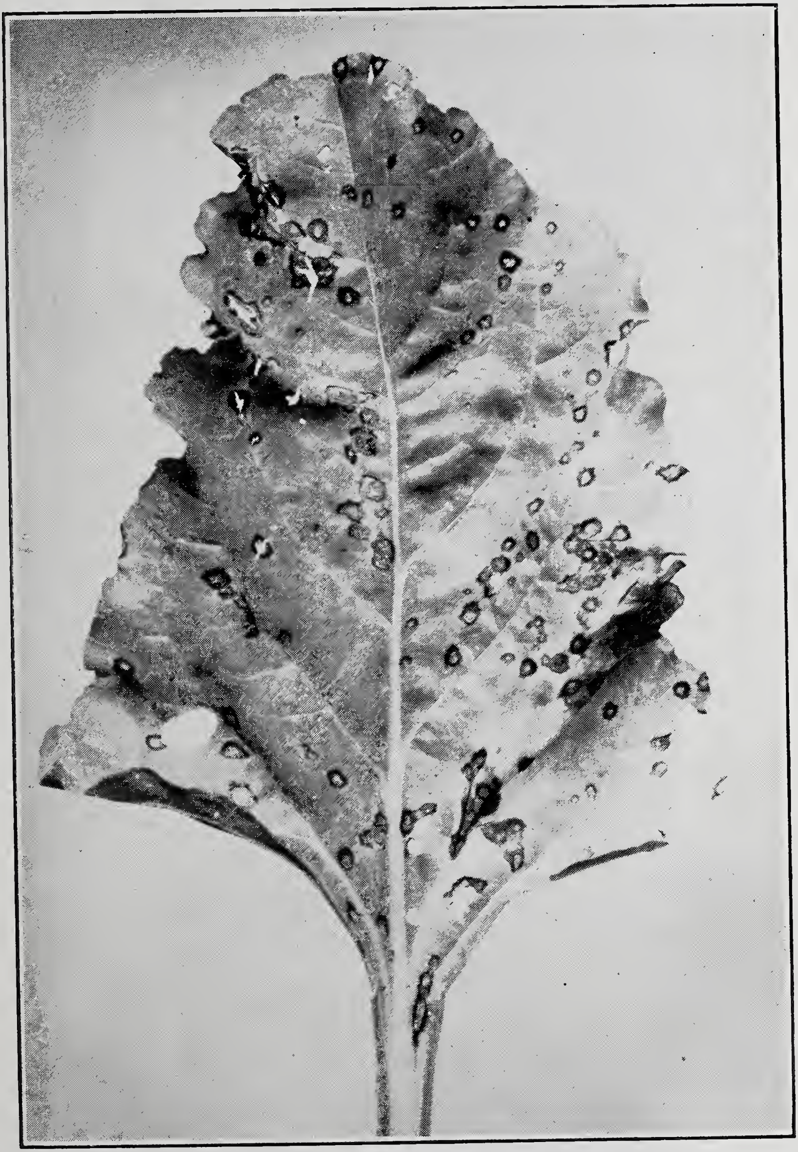

FIGURE 4.—Leaf spot of sugar beet.

grown commercially in nematode-infested regions, undoubtedly certain regulations will have to be made regarding the shipping of the beets.

The nematode root gall problem would be very serious in the sandy regions of the state but not so important in the alluvial sections.

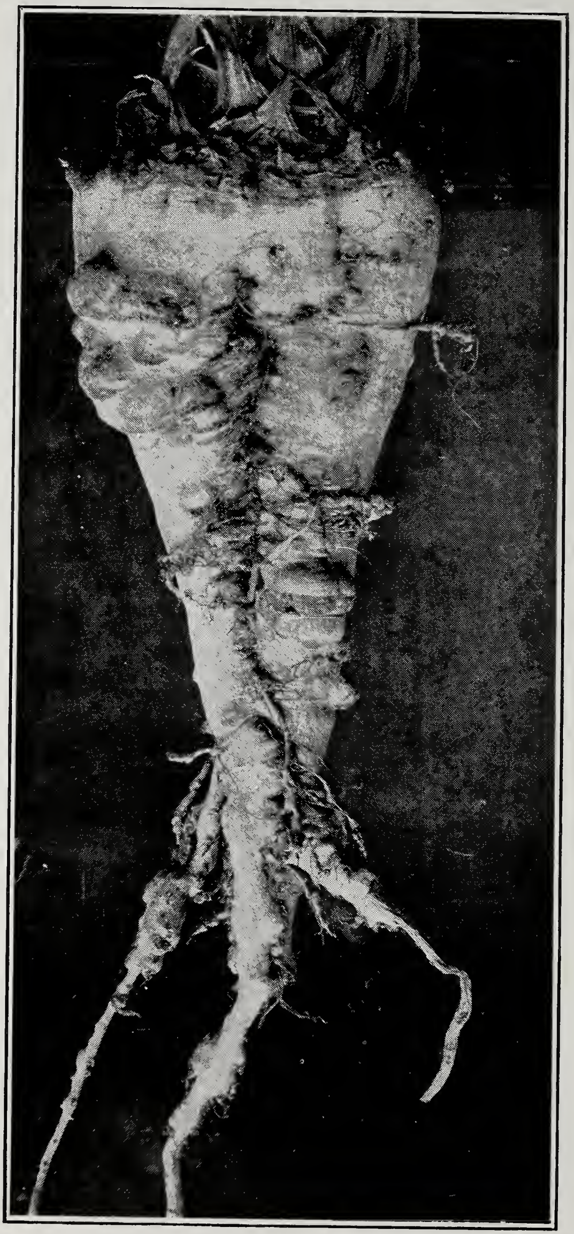

FIGURE 5.—Nematode galls on sugar beet.

SUMMARY

1. Sugar beets grown in Louisiana have been seriously affected with a number of different diseases.

2. Two rot diseases seemed to be the limiting factors when an attempt was made to grow beets commercially in 1926 and 1927.

3. One of the rot diseases, the Rhizoctonia rot, is most severe in the wet, cold weather of late winter and early spring, and practically disappears with the approach of warm weather. This disease sometimes causes losses as high as 50 percent.

4. The other rot disease, the Sclerotium rot, becomes serious when the beets are left in the field during warm weather. It is also favored by excessive moisture. The damage caused by the rot is not confined to the field, as heavy losses may also occur while the beets are being transported to the mill. Partially rotted beets have a very low sucrose content and low purity and are worthless.

5. Methods of controlling the Sclerotium rot have as yet not been successful. The application of lime to the soil at the rate of two to four tons per acre did not decrease the amount of Sclerotium rot, although lime applied to the beets in the cars and in storage did decrease the rot to a certain extent.

6. Fertilizer applications apparently had no effect in reducing the Sclerotium rot.

7. No varietal resistance to Sclerotium rot has as yet been observed.

8. The leaf spot disease is a serious disease during warmer weather and is capable of materially reducing the crop.

9. The larger leaf spot disease occurs in Louisiana but is not serious. It does not produce a rotting of the beets.

10. Beets are very susceptible to nematode root galls. This disease will become a grave problem if beets are grown commercially in the sandy soils.

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JUNE, 1936 LOUISIANA BULLETIN No. 274

Sugar Cane Variety Report

SEASON OF 1935

By

C. B. GOUAUX
AND
E. C. SIMON

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AGRICULTURAL EXPERIMENT STATIONS
C. T. DOWELL, *Director*

Sugar Cane Variety Report

SEASON OF 1935

EXPERIMENT STATION TEST FIELDS

C. B. Gouaux

The sugar cane variety work of the Louisiana Experiment Station was conducted at ten locations in representative areas of the cane belt during the season of 1935. There was a total of twenty-seven test fields with an average of eight varieties planted on a comparative basis as first and second stubble, and from eight to as high as fourteen varieties on a plant cane basis. Data on the commercial varieties are published here.

During the harvesting period from October 8 to December 18, the test fields were harvested and the final results, consisting of field yields and chemical data, were obtained. The second stubble test fields were harvested during the early part of grinding, and were followed by the first stubble and fall plant test fields.

The work at the test fields was greatly facilitated by the splendid cooperation of the test fields cooperators. The weighing of the numerous variety plots on plantation scales, and the large number of sugar-house mill tests of varieties were performed under close supervision and with the assistance of field overseers and factory chemists. All of the analyses of Crusher Juices of the varieties and the calculation of same to Normal Juices were made by the chemists of the sugar factories cooperating in the work.

The test field results for the season of 1935 are presented in tables 1 to 10, inclusive. The regular "Louisiana Sugar Cane Contract," using a basis of 11½ to 12½ per cent sucrose in Normal Juice, was used in evaluating the varieties. A cost of $1.00 per ton was used as a total cane harvesting expense. An average price of $3.07 for 96 Test sugar, taken from official Louisiana Sugar and Rice Exchange weekly averages from October 24, 1935, to January 2, 1936, was established as the base settlement price.

CULTIVATION AND FERTILIZATION OF TEST FIELDS

At all of the test fields, the Experiment Station method of cultivation was practiced, with deep plow work in the early spring, light cultivation and hoeing during the early growing period, and laying-by early with cultivators in the latter part of May and early June. On all of the plant cane fields, the preceding crop was a summer legume which was plowed under early in the fall before planting time. The plant cane fields did not receive any fertilizer treatment.

All of the first and second stubble test fields, with the exception of Youngsville, Billeaud, and Jeanerette fields, were fertilized during the latter part of March and early April. The Experiment Station recommendation of 36 pounds of readily available nitrogen per acre was generally used on these stubble fields.

SEASON OF 1935

During the first two months of the year, the usual field operations of destroying old stubble and preparing corn and legume lands, together with the preliminary work of sinking and wrapping cane middles, was performed during intervals of favorable weather. The rainfall during the two months was slightly below normal. On January 22 there was a severe cold wave, with minimum temperatures ranging between 17° and 24° F. in the southern portion of the state. This was accompanied by a snow fall of from 1½ to 3 inches, and as high as 5½ inches in the Meeker section. With the exception of the killing of young green cane shoots to a depth of about one-half inch below the ground surface, there was practically no injury to the fall plant and stubble cane.

TABLE A—RAINFALL DISTRIBUTION AT THE TEST FIELDS

(Season of 1935, expressed in inches)

	January		February		March		April		May		June	
Location	Days	In.	Days	In.	Days	In.	Days	In.	Days	In.	Days	In.
Cinclare	5	4.37	7	4.89	9	6.20	7	7.11	5	3.00	10	3.40
Napoleonville	1	4.28	5	7.12	7	8.60	6	8.18	5	2.06	7	4.60
Reserve	6	2.03	7	6.10	10	6.46	11	7.04	8	2.26	14	9.29
Franklin	5	3.81	7	6.77	10	4.82	8	7.01	4	1.95	11	8.01
Jeanerette	5	3.44	6	5.01	6	6.11	9	4.85	7	4.56	12	5.26
Meeker	4	2.35	5	2.59	6	10.92	7	4.09	5	14.14	7	7.35
Youngsville	2	1.75	7	5.20	5	4.02	5	4.12	3	5.10	10	6.14

	July		August		September		October		November		December	
Location	Days	In.	Days	In.	Days	In.	Days	In.	Days	In.	Days	In.
Cinclare	14	8.22	12	6.78	7	3.30	4	.65	4	1.60	8	8.60
Napoleonville	9	6.00	4	2.70	4	4.89	0	0.00	1	1.46	5	7.68
Reserve	20	8.29	14	6.56	10	2.24	1	.11	3	1.63	9	7.16
Franklin	17	12.21	13	4.96	10	8.99	4	.81	2	2.10	9	7.14
Jeanerette	15	5.41	14	6.61	10	5.53	3	.87	2	1.23	8	5.82
Meeker	9	4.82	5	4.74	6	5.60	1	.55	4	4.51	6	9.14
Youngsville	8	5.49	6	3.88	10	6.50	1	.91	3	1.00	5	6.93

TOTAL RAINFALL

Location	Total No. Inches
Cinclare	58.12
Napoleonville	57.57
Reserve	59.17
Franklin	68.58
Jeanerette	54.70
Meeker	70.80
Youngsville	51.04

Rainfall during the month of March was slightly above average, with a freeze occurring at most places on March 3. The bulk of the preliminary cane field operations, consisting of off-barring, stubble shaving, scraping plant cane and fertilizing stubble cane, was performed during the middle of March to the middle of April. Plantings of corn and legumes were also made at this time.

There was considerable cultivation activity in the cane belt during the latter part of May, on account of interruptions from rains in the early part of the month. The laying-by of cane was started at this time, the majority of the work being completed during June.

On July 1, the cane crop showed better stands and more advanced growth than the 1934 crop on the same date. The summer months of July, August, and September were generally favorable, with sufficient rainfall and warm weather, and the cane crop responded by making an excellent growth.

The cane harvesting season started in early October and extended through December, with some few mills operating as late as January 18, 1936. The weather conditions during the grinding season were ideal, with very dry weather in October, November, and most of December. This, together with the absence of severe freezes, except bud-killing freezes in late November and early December, made it possible to save a bumper crop of cane which gave high field and sugar yields throughout the sugar cane belt.

TABLE B—MINIMUM TEMPERATURES AT THE TEST FIELDS

For November and December, 1935

(Expressed in Degrees Fahrenheit)

Date	Cheneyville	Cinclare	Donaldsonville	Reserve	Franklin	Jeanerette	Lafayette
11-17	30	----	----	----	----	31	----
11-21	32	----	----	----	----	----	----
11-23	28	31	30	----	----	31	30
11-24	----	----	----	----	----	30	32
11-25	----	----	----	----	----	32	----
11-30	----	----	----	----	----	32	----
12- 2	----	32	----	----	----	----	----
12- 3	23	29	30	31	32	----	28
12-12	32	----	----	----	----	----	----
12-13	28	30	31	32	31	30	29
12-17	31	----	----	----	----	----	----
12-20	31	----	----	----	----	----	----
12-21	25	26	30	30	29	29	27
12-22	32	----	----	----	32	32	----
12-23	----	32	----	31	30	31	----
12-25	29	30	32	32	----	----	32
12-26	27	28	30	31	31	31	29
12-27	23	24	25	26	26	28	24
12-30	24	28	29	30	30	27	26

Note: Data from U. S. Department of Agriculture, Weather Bureau.

TABLE 1—CINCLARE TEST FIELDS

(Sandy Soil—Yazoo Series)

	———Normal Juice———			Tons Per	——Value——		Less $1	
Variety	Brix	Sucrose	Purity	Acre	Ton	Acre	Harvest	Balance
Second Stubble								
P.O.J. 36M	15.27	12.24	80.16	14.00	$3.07	$ 42.98	$14.00	$28.98
P.O.J. 213	14.69	11.64	79.22	16.25	3.07	49.89	16.25	34.14
P.O.J. 234	13.68	10.71	78.33	3.16	2.58	8.15	3.16	4.99
Co. 281	16.17	13.38	82.73	23.45	3.26	76.45	23.45	53.00
Co. 290	14.98	11.52	76.93	43.60	3.07	133.85	43.60	90.25
C.P. 807	13.58	10.55	77.69	33.80	2.49	84.16	33.80	50.36
C.P. 28-11	16.91	13.61	80.52	32.67	3.31	108.14	32.67	75.47
C.P. 28-19	16.97	14.19	83.62	25.22	3.43	86.50	25.22	61.28
First Stubble								
P.O.J. 234	16.62	14.07	84.69	14.47	3.41	49.34	14.47	34.87
Co. 281	16.72	14.10	84.36	20.85	3.41	71.10	20.85	50.25
Co. 290	14.46	10.95	75.76	38.18	2.73	104.23	38.18	66.05
C.P. 807	12.67	9.37	73.96	33.35	1.59	53.03	33.35	19.68
C.P. 28-11	16.59	12.91	77.81	29.17	3.16	92.18	29.17	63.01
C.P. 28-19	17.61	14.75	83.77	27.93	3.55	99.15	27.93	71.22
C.P. 29-320	16.82	13.88	82.51	21.68	3.37	73.06	21.68	51.38
Fall Plant								
P.O.J. 234	16.01	13.67	85.36	22.95	3.32	76.19	22.95	53.24
Co. 281	16.89	14.39	85.22	29.75	3.48	103.53	29.75	73.78
Co. 290	15.06	11.41	75.77	42.30	3.01	127.32	42.30	85.02
C.P. 807	14.26	11.44	80.24	37.30	3.03	113.02	37.30	75.72
C.P. 28-11	16.74	13.59	81.16	31.15	3.30	102.80	31.15	71.65
C.P. 28-19	17.90	15.13	84.52	31.35	3.64	114.11	31.35	82.76
C.P. 29-320	16.88	14.13	83.71	27.00	3.42	92.34	27.00	65.34

Notes: Second Stubble—Harvesting dates: 12/4/33; 11/5/34 and 11/4/35. Planted September 22-23, 1932.

First Stubble—Harvesting dates: 11/26/34 and 11/4/35. Planted September 29, 1933.

Plant Cane—Harvested 12/3/35. Planted September 25-26, 1934.

The results of first and second stubble and fall plant varieties of Cinclare test fields indicate a definite superiority for Co. 290, C.P. 28-19, C.P. 28-11, Co. 281, and C.P. 29-320. Of these four varieties, C.P. 28-19 gave the highest sucrose tests, followed by Co. 281, C.P. 29-320, and C.P. 28-11. Co. 290 was considerably lower in sucrose tests (10.95 to 11.52%), but much higher in field yields.

C.P. 28-19 and Co. 281 showed higher sucrose tests and tonnages than P.O.J. 234 in the first and second stubble and plant cane tests.

C.P. 29-320 was higher in fall plant and stubble field yields than P.O.J. 234, with higher sucrose as plant cane and slightly lower sucrose as first stubble.

TABLE 2—GLENWOOD TEST FIELDS
(Sandy Soil—Yazoo Series)

	———Normal Juice———			Tons Per Acre	——Value——		Less $1 Harvest	
Variety	Brix	Sucrose	Purity		Ton	Acre		Balance
Second Stubble								
P.O.J. 36M	15.94	12.76	80.04	14.05	$3.13	$ 43.98	$14.05	$29.93
P.O.J. 213	15.89	13.05	82.16	9.90	3.19	31.58	9.90	21.68
P.O.J. 234	16.08	13.17	81.92	3.35	3.21	10.75	3.35	7.40
Co. 281	16.86	13.98	82.95	15.65	3.39	53.05	15.65	37.40
Co. 290	15.96	12.07	75.63	40.05	3.07	122.95	40.05	82.90
C.P. 807	14.92	11.59	77.69	26.95	3.07	82.74	26.95	55.79
C.P. 28-11	17.38	13.94	80.18	28.40	3.38	95.99	28.40	67.59
C.P. 28-19	17.78	14.72	82.79	22.25	3.55	78.99	22.25	56.74
First Stubble								
P.O.J. 234	17.89	15.37	85.90	11.45	3.69	42.25	11.45	30.80
Co. 281	16.85	14.08	83.56	17.75	3.41	60.53	17.75	42.78
Co. 290	15.10	11.58	76.73	34.65	3.07	106.38	34.65	71.73
C.P. 807	15.26	12.17	79.76	22.85	3.07	70.15	22.85	47.30
C.P. 28-11	18.02	14.77	81.98	22.50	3.56	80.10	22.50	57.60
C.P. 28-19	18.50	15.78	85.32	24.40	3.77	91.99	24.40	67.59
C.P. 29-320	17.65	14.81	83.93	26.20	3.57	93.53	26.20	67.33
Fall Plant								
P.O.J. 234	16.24	13.10	80.68	16.05	3.20	51.36	16.05	35.31
Co. 281	16.66	13.50	81.03	25.70	3.28	84.30	25.70	58.60
Co. 290	16.44	12.58	76.53	40.45	3.09	124.99	40.45	84.54
C.P. 807	15.65	12.27	78.42	29.30	3.07	89.95	29.30	60.65
C.P. 28-11	18.11	14.69	81.15	31.95	3.54	113.10	31.95	81.15
C.P. 28-19	18.65	15.96	85.60	30.80	3.81	117.35	30.80	86.55
C.P. 29-320	16.94	13.86	81.85	26.95	3.36	90.55	26.95	63.60

Notes: Second Stubble—Harvesting dates: 12/5-7/33; 11/7/34 and 11/5/35. Planted September 24, 1932.

First Stubble—Harvesting dates: 11/27/34 and 11/5/35. Planted September 22, 1933.

Fall Plant—Harvested 12/3/35. Planted September 24-25, 1934.

In the first and second stubble and plant cane results of Glenwood test fields, Co. 290, C.P. 28-19, C.P. 28-11 and C.P. 29-320 were the highest ranking varieties. C.P. 28-19 gave the highest sucrose tests followed by C.P. 28-11, Co. 281, and

C.P. 29-320. Co. 290 gave standard sucrose tests with the highest tonnages, being greatly superior to C.P. 807.

TABLE 3—RESERVE TEST FIELDS
(Sandy Soil—Yazoo Series)

	———Normal Juice———			Tons Per Acre	——Value——		Less $1 Harvest	Balance
Variety	Brix	Sucrose	Purity		Ton	Acre		
Second Stubble								
P.O.J. 36M	17.25	14.29	82.86	15.65	$3.45	$ 53.99	$15.65	$38.34
P.O.J. 213	16.43	13.15	80.03	13.16	3.21	42.24	13.16	29.08
P.O.J. 234	17.55	14.46	82.38	3.33	3.49	11.62	3.33	8.29
Co. 281	17.41	14.41	82.76	20.35	3.48	70.82	20.35	50.47
Co. 290	16.57	13.05	78.73	33.65	3.19	107.34	33.65	73.69
C.P. 807	15.50	12.45	80.32	27.58	3.07	84.67	27.58	57.09
C.P. 28-11	18.13	14.44	79.66	30.37	3.49	105.99	30.37	75.62
C.P. 28-19	19.40	16.46	84.85	26.92	3.92	105.53	26.92	78.61
First Stubble								
P.O.J. 234	17.74	14.67	82.71	17.00	3.54	60.18	17.00	43.18
Co. 281	16.77	13.47	80.31	20.20	3.28	66.26	20.20	46.06
Co. 290	15.87	12.36	77.91	36.65	3.07	112.52	36.65	75.87
C.P. 807	15.15	12.06	79.62	29.30	3.07	89.95	29.30	60.65
C.P. 28-11	17.40	13.67	78.54	26.43	3.32	87.75	26.43	61.32
C.P. 28-19	18.77	15.70	83.67	24.00	3.76	90.24	24.00	66.24
C.P. 29-320	17.82	14.35	80.53	26.24	3.47	91.05	26.24	64.81
Fall Plant								
P.O.J. 234	14.18	10.72	75.59	19.80	2.59	51.28	19.80	31.48
Co. 281	16.41	13.25	80.75	36.20	3.23	116.93	36.20	80.73
Co. 290	15.01	11.04	73.54	43.20	2.79	120.53	43.20	77.33
C.P. 807	14.81	11.67	78.82	31.00	3.07	95.17	31.00	64.17
C.P. 28-11	15.74	12.14	77.10	35.75	3.07	109.75	35.75	74.00
C.P. 28-19	18.22	14.29	78.44	35.30	3.45	121.79	35.30	86.49
C.P. 29-320	17.00	13.17	77.47	40.15	3.21	128.88	40.15	88.73

Notes: Second Stubble—Harvesting dates: 12/12-14/33; 11/12-13/34 and 11/5/35. Planted October 7, 1932.

First Stubble—Harvesting dates: 12/3-4/34 and 11/6/35. Planted September 25, 1933.

Fall Plant—Harvested 12/5/35. Planted October 8, 1934.

In the Reserve first and second stubble and plant cane results, C.P. 28-19, Co. 290, C.P. 29-320, and C.P. 28-11 were the leading varieties.

From the standpoint of highest sucrose, C.P. 28-19 was first, followed by Co. 281, C.P. 29-320, and C.P. 28-11.

Co. 290 gave the highest tonnages, with the sucrose content ranging between 11 and 13 per cent. This variety proved superior to C.P. 807 in the first and second stubble and fall plant cane results.

TABLE 4—MEEKER TEST FIELDS
(Yahola Very Fine Sandy Loam)

Variety	Normal Juice			Tons Per Acre	Value		Less $1 Harvest	Balance
	Brix	Sucrose	Purity		Ton	Acre		
Second Stubble								
P.O.J. 36M	13.74	9.87	71.83	14.00	$2.07	$ 28.98	$14.00	$14.98
P.O.J. 213	13.29	9.10	68.46	21.35	1.43	30.53	21.35	9.18
P.O.J. 234	15.07	11.30	74.98	3.52	2.95	10.38	3.52	6.86
Co. 281	13.91	10.26	73.75	20.00	2.31	46.20	20.00	26.20
Co. 290	13.72	9.87	71.93	34.80	2.07	72.04	34.80	37.24
C.P. 807	12.63	8.50	67.30	28.70	1.15	33.01	28.70	4.31
C.P. 28-11	15.50	12.02	77.54	27.14	3.07	83.32	27.14	56.18
C.P. 28-19	13.67	9.80	71.72	28.20	2.03	57.25	28.20	29.05
First Stubble								
P.O.J. 234	16.83	13.50	80.20	25.10	3.28	82.33	25.10	57.23
Co. 281	15.40	11.39	73.96	34.95	3.00	104.85	34.95	69.90
Co. 290	13.80	9.60	69.56	58.95	1.90	112.01	58.95	53.06
C.P. 807	12.53	8.44	67.35	32.30	1.13	36.50	32.30	4.20
C.P. 28-11	17.11	12.45	72.76	40.05	3.07	122.95	40.05	82.90
C.P. 28-19	17.26	13.63	78.96	35.10	3.31	116.18	35.10	81.08
C.P. 29-320	16.28	12.79	78.56	44.10	3.13	138.03	44.10	93.93
Fall Plant								
P.O.J. 234	13.92	10.07	72.34	22.35	2.19	48.95	22.35	22.60
Co. 281	14.79	11.06	74.78	29.45	2.80	82.46	29.45	53.01
Co. 290	12.85	8.16	63.50	56.42	.98	55.29	56.42	−1.13
C.P. 807	13.33	9.46	70.97	43.25	1.61	69.63	43.25	26.38
C.P. 28-11	15.28	11.31	74.04	30.25	2.95	89.24	30.25	58.99
C.P. 28-19	16.25	12.78	78.64	39.15	3.13	122.54	39.15	83.40
C.P. 29-320	15.86	12.50	78.81	43.55	3.07	133.70	43.55	90.15

Notes: Second Stubble—Harvesting dates: 11/25/33; 11/2/34 and 10/28/35. Planted October 10, 1932.

First Stubble—Harvesting dates: 12/6-7/34 and 11/14/35. Planted October 8, 1933.

Fall Plant—Harvested 11/26-28/35. Planted October 11, 1934.

The eyes and terminal buds of all plant cane varieties were killed by freezes of November 17 and 23rd., with minimum temperatures of 30 and 28 degrees F., respectively. The following varieties were very badly lodged: P.O.J. 234, Co. 290, C.P. 807, and C.P. 28-19. Co. 281 and C.P. 29-320 were fairly erect.

The results of Meeker second stubble indicate that C.P. 28-11, Co. 290, C.P. 28-19, and Co. 281 were the leading varieties. The fall plant and first stubble data show that C.P. 29-320 is the outstanding variety, followed by C.P. 28-11, C.P. 28-19, and Co. 281 in the first stubble, and by C.P. 28-19 and Co. 281 in the fall plant cane.

Co. 281 was definitely superior to P.O.J. 234 in the fall plant and stubble tests.

TABLE 5—BUBENZER SYRUP TEST FIELDS
(Yahola Very Fine Sandy Loam)

	———Syrup Mill Juices———			Extraction	Tons Per Acre	—Gallons Syrup—	
Variety	Brix	Sucrose	Purity			Per Ton	Per Acre
Second Stubble							
P.O.J. 36	16.60	14.01	84.40	57.00	13.01	19.31	251.22
P.O.J. 36M	16.85	14.09	83.62	55.00	11.35	18.91	214.63
P.O.J. 213	16.60	14.08	84.82	57.50	12.25	19.48	238.63
P.O.J. 234	17.00	14.06	82.71	56.50	12.25	19.60	240.10
Co. 281	16.70	13.78	82.51	55.75	12.50	19.00	237.50
Co. 290	16.60	13.77	82.95	58.50	22.90	19.82	453.88
C.P. 807	15.30	12.69	82.94	54.00	22.30	16.86	375.98
C.P. 28-11	16.70	13.12	78.56	53.25	18.40	18.15	333.96
C.P. 28-19	16.30	12.98	79.63	53.50	7.15	17.80	127.27
First Stubble							
P.O.J. 36	16.80	14.34	85.36	67.00	23.70	22.97	544.39
P.O.J. 36M	17.50	15.55	88.86	67.00	20.85	23.93	498.94
P.O.J. 213	16.50	14.40	87.27	66.50	30.00	22.39	671.70
P.O.J. 234	17.70	15.62	88.25	65.00	24.95	23.48	585.83
Co. 281	17.30	15.04	86.94	69.00	23.05	24.36	561.50
Co. 290	15.80	12.93	81.84	70.00	42.00	22.57	947.94
C.P. 28-11	17.30	14.16	81.85	61.00	33.30	21.54	717.28
C.P. 28-19	18.00	15.36	85.33	60.00	32.35	22.04	712.99
C.P. 29-320	17.50	15.25	87.14	63.50	35.00	22.68	793.80
Fall Plant							
P.O.J. 36	13.45	9.74	72.41	66.00	30.50	18.12	552.66
Co. 281	14.85	11.65	78.45	65.00	32.50	19.70	640.25
Co. 290	14.45	10.30	71.28	70.50	56.40	20.79	1172.56
C.P. 28-11	16.60	12.66	76.26	66.00	29.35	22.36	656.27
C.P. 28-19	16.60	13.35	80.42	57.50	34.75	19.48	676.93
C.P. 29-320	16.10	12.69	78.81	63.00	33.60	20.70	695.52

Notes: Samples of 100 pounds of each variety were crushed at Bubenzer Syrup Mill, and juice samples and weights were taken. Juice analyses of first and second stubble were made at Augusta Factory of Haas Investment Co., Bunkie, La., and analyses of fall plant cane varieties were made by Meeker Sugar Refining Co., Meeker, La.

Second Stubble—Harvesting dates: 12/19-21/33; 11/20/34 and 11/24/35. Planted October 8, 1932.

First Stubble—Harvesting dates: 12/6/34 and 11/14/35. Planted October 4, 1933.

Fall Plant—Harvested 11/27/35. Planted October 12, 1933.

Syrup yields calculated by using following formula:

$$\frac{2000 \times \text{Extraction} \times \text{Brix} \times .85}{8.33}$$

The Bubenzer second stubble results indicate that Co. 290, P.O.J. 234, P.O.J. 213, and P.O.J. 36 gave highest calculated syrup per ton yields, while Co. 290, C.P. 807, C.P. 28-11, and P.O.J. 36 gave the highest syrup per acre yields.

In the first stubble results, Co. 281, P.O.J. 36M, P.O.J. 234, and P.O.J. 36 were highest in syrup per ton yields, and Co. 290, C.P. 29-320, C. P. 28-11, and C.P. 28-19 gave the highest syrup per acre yields.

C.P. 28-11, Co. 290, C.P. 29-320, and Co. 281 fall plant varieties were highest in syrup per ton yields, while Co. 290, C.P. 29-320, C.P. 28-19, and C.P. 28-11 were the leading varieties in syrup per acre yields.

TABLE 6—SHIRLEY TEST FIELD

(Yahola Very Fine Sandy Loam)

	———Normal Juice———			Tons Per	——Value——		Less $1	
Variety	Brix	Sucrose	Purity	Acre	Ton	Acre	Harvest	Balance
P.O.J. 36	15.35	11.91	77.62	23.90	$3.07	$ 73.37	$23.90	$49.47
P.O.J. 234	17.20	14.32	83.27	21.40	3.46	74.04	21.40	52.64
Co. 281	16.71	13.43	80.38	23.40	3.27	76.52	23.40	53.12
Co. 290	15.25	11.33	74.27	33.65	2.97	99.94	33.65	66.29
C.P. 807	13.21	9.46	71.64	41.35	1.61	66.57	41.35	25.22
C.P. 28-11	16.81	13.16	78.26	32.70	3.21	104.97	32.70	72.27
C.P. 28-19	17.49	14.22	81.30	27.10	3.44	93.22	27.10	66.12
C.P. 29-320	17.10	14.15	82.76	33.00	3.42	112.86	33.00	79.86

Notes: First Stubble—Harvesting dates: 11/19/34 and 10/23-24/35. Planted October 4, 1933.

The results of the Shirley first stubble test field indicate that C.P. 29-320 was the highest ranking variety, followed by C.P. 28-11, Co. 290, and C.P. 28-19. P.O.J. 234, slightly outranked by Co. 281, was higher in sucrose content. The four leading varieties from standpoint of highest sucrose were as follows: P.O.J. 234, C.P. 28-19, C.P. 29-320 and Co. 281.

The Shirley fall plant cane test field was divided into three equal parts, and the first part was harvested and milled November 22, before a bud killing freeze. The second part was windrowed November 30, after the buds and most of the eyes were killed by late November freezes, and the third part was left standing until December

16. Both the standing and windrowed canes were harvested for the mill on December 16, and milled at Augusta factory on December 18. The results of this series of tests are presented in Table 6A.

In the tests that were made on November 22, the four leading varieties were as follows: C.P. 29-320, C.P. 28-19, C.P. 28-11, and Co. 281.

Of the windrowed canes which were in windrow sixteen days, the varieties making the best showing ranked as follows: Co. 281, C.P. 29-320, C.P. 28-19, and P.O.J. 234.

Of the standing cane, which showed less deterioration than the windrowed cane, the varieties ranked as follows: C.P. 29-320, Co. 281, C.P. 28-11, and C.P. 28-19.

The varieties making the poorest showing under windrow conditions were C.P. 807, Co. 290, and C.P. 28-11.

TABLE 6A—SHIRLEY TEST FIELD
(Yahola Very Fine Sandy Loam)
FALL PLANT

	——Normal Juice——				Tons Per	—Value—		Less $1		
Variety	Brix	Sucrose	Purity	Acidity	Acre	Ton	Acre	Harvest	Balance	Date
P.O.J. 234	16.13	12.97	80.39	....	26.25	$3.17	$ 83.21	$26.25	$56.96	11-22
P.O.J. 234s	16.08	12.60	78.34	1.3	23.45	3.09	72.46	23.45	49.01	12-18
P.O.J. 234w	16.76	10.23	60.32	.9	26.00	2.29	59.54	26.00	33.54	12-18
Co. 281	15.54	12.38	79.65	....	30.35	3.07	93.17	30.35	62.82	11-22
Co. 281s	15.50	11.53	74.41	1.5	34.45	3.07	105.76	34.45	71.31	12-18
Co. 281w	15.64	11.99	76.69	1.6	33.80	3.07	102.23	33.30	68.93	12-18
Co. 290	14.18	10.08	71.08	....	44.80	2.20	98.56	44.80	53.76	11-22
Co. 290s	13.35	9.01	67.48	1.7	35.80	1.38	49.40	35.80	13.60	12-18
Co. 290w	13.98	7.26	51.91	1.6	45.15	.47	21.22	45.15	–23.93	12-18
C.P. 807	13.79	10.14	73.52	....	41.10	2.23	91.65	41.10	50.55	11-22
C.P. 807s	13.74	9.59	69.81	....	40.00	1.90	76.00	40.00	36.00	12-18
C.P. 807w	15.01	6.61	44.07	1.0	37.80	.10	3.78	37.80	–34.02	12-18
C.P. 28-11	16.13	12.04	74.67	....	33.80	3.07	103.77	33.80	69.97	11-22
C.P. 28-11s	16.57	12.44	75.05	2.0	34.25	3.07	105.15	34.25	70.90	12-18
C.P. 28-11w	16.87	8.49	50.31	1.6	32.75	.96	31.44	32.75	– 1.31	12-18
C.P. 28-19	16.51	12.72	77.02	....	34.80	3.12	108.58	34.80	73.78	11-22
C.P. 28-19s	16.38	12.67	77.36	....	31.55	3.11	98.12	31.55	66.57	12-18
C.P. 28-19w	16.87	10.53	62.43	1.5	31.90	2.47	78.79	31.90	46.89	12-18
C.P. 29-320	17.19	13.98	81.31	....	38.20	3.39	129.50	38.20	91.30	11-22
C.P. 29-320s	16.57	12.34	74.46	1.6	34.45	3.07	105.76	34.45	71.31	12-18
C.P. 29-320w	17.31	11.85	68.46	1.4	34.65	3.07	106.38	34.65	71.73	12-18

Note: s equals standing cane milled December 18, 1935.
w equals windrowed cane milled December 18, 1935.
First line of figures for each variety, milled November 22, 1935.
Planted September 26, 1934.

TABLE 7—IBERIA LIVESTOCK EXPERIMENT FARM TEST FIELDS
(Iberia Clay Loam)

	Normal Juice			Tons Per	Value		Less $1	
Variety	Brix	Sucrose	Purity	Acre	Ton	Acre	Harvest	Balance
Second Stubble								
P.O.J. 36M	13.95	9.43	67.60	5.05	$1.55	$ 7.83	$ 5.05	$ 2.78
Co. 281	15.30	11.56	75.56	8.25	3.07	25.33	8.25	17.08
Co. 290	15.35	11.01	71.73	17.35	2.81	48.75	17.35	31.40
C.P. 807	14.13	10.99	77.78	15.50	2.76	42.78	15.50	27.28
C.P. 28-11	15.60	12.53	80.32	12.85	3.08	39.58	12.85	26.73
C.P. 28-19	16.57	13.41	80.93	18.45	3.27	60.33	18.45	41.88
First Stubble								
P.O.J. 234	14.77	11.35	76.84	2.90	2.98	8.64	2.90	5.74
Co. 281	15.04	11.52	76.60	15.40	3.07	47.28	15.40	31.88
Co. 290	14.84	11.05	74.46	22.60	2.79	63.05	22.60	40.45
C.P. 807	13.28	9.92	74.70	18.40	2.10	38.64	18.40	20.24
C.P. 28-11	15.55	11.37	73.12	17.85	2.99	53.37	17.85	35.52
C.P. 28-19	15.87	12.28	77.38	18.70	3.07	57.41	18.70	38.71
C.P. 29-320	16.03	12.77	79.66	21.35	3.12	66.83	21.35	45.48
Fall Plant								
P.O.J. 234	16.80	13.44	80.00	17.35	3.27	56.73	17.35	29.38
Co. 281	16.70	13.13	78.62	19.50	3.21	62.60	19.50	43.10
Co. 290	15.30	10.67	69.73	30.15	2.56	77.18	30.15	47.03
C.P. 807	15.60	12.18	78.07	26.25	3.07	80.59	26.25	54.34
C.P. 28-11	19.30	15.60	80.82	19.50	3.74	72.93	19.50	53.43
C.P. 28-19	19.00	15.69	82.57	23.35	3.76	87.80	23.35	64.45
C.P. 29-320	18.00	14.11	78.38	29.85	3.42	102.09	29.85	72.24

Notes: Second Stubble—Harvesting dates: 11/27-28/33; 10/29/34 and 10/24-26/35. Planted October 12, 1932.

First Stubble—Harvesting dates: 11/16-19/34 and 10/28-30/35. Planted October 16, 1933.

Fall Plant—Harvested 11/20/35. Planted October 5, 1934.

The three test fields, first and second stubble and fall plant cane, received very little cultivation during the season. These fields were off-barred at the regular time, hoed once, dirted back with plows and the middles fluked out in early June.

In the second stubble tests, C.P. 28-19, Co. 290, and C. P. 807 were the leading varieties, while C.P. 28-19, C.P. 28-11, and Co. 281 were highest from standpoint of sucrose.

C.P. 29-320, Co. 290, and C.P. 28-19 were the leading first stubble varieties. C.P. 29-320 gave the highest sucrose test, followed by C.P. 28-19, Co. 281, and C.P. 28-11.

In the fall plant cane, C.P. 29-320 was the leading variety, followed by C.P. 28-19. From the standpoint of highest sucrose, C.P. 28-19 was first, followed by C.P. 28-11 and C.P. 29-320.

TABLE 8—STERLING TEST FIELDS
(Sharkey Loam)

	Normal Juice			Tons Per	Value		Less $1	
Variety	Brix	Sucrose	Purity	Acre	Ton	Acre	Harvest	Balance
Second Stubble								
P.O.J. 36M	16.53	14.08	85.19	9.05	$3.41	$ 30.86	$ 9.05	$21.81
P.O.J. 213	(No mill test)			4.25				
P.O.J. 234	(No mill test)			1.98				
Co. 281	17.46	14.73	84.37	7.50	3.55	26.63	7.50	19.13
Co. 290	17.03	14.19	83.35	31.00	3.43	106.33	31.00	75.33
C.P. 807	16.00	13.45	84.04	20.90	3.27	68.34	20.90	47.44
C.P. 28-11	18.26	15.77	86.35	18.80	3.77	70.88	18.80	52.08
First Stubble								
P.O.J. 234	15.70	12.81	81.62	14.64	3.14	45.97	14.64	31.33
Co. 281	17.86	15.25	85.39	21.05	3.66	77.04	21.05	55.99
Co. 290	16.49	12.83	77.79	25.09	3.14	78.78	25.09	53.69
C.P. 807	16.00	13.17	82.31	27.55	3.21	88.44	27.55	60.89
C.P. 28-11	18.68	15.58	83.40	19.82	3.73	73.93	19.82	54.11
C.P. 28-19	19.46	16.74	86.02	25.82	3.98	102.76	25.82	76.94
C.P. 29-320	18.73	16.07	85.82	26.36	3.84	101.22	26.36	74.86
Fall Plant								
P.O.J. 234	18.01	15.62	86.72	13.65	3.74	51.05	13.65	37.40
Co. 281	18.35	15.44	84.14	16.80	3.70	62.16	16.80	45.36
Co. 290	17.33	14.09	81.31	22.85	3.41	77.91	22.85	55.06
C.P. 807	16.65	13.71	82.37	19.45	3.33	64.77	19.45	45.32
C.P. 28-11	18.90	15.58	82.44	19.60	3.73	73.11	19.60	53.51
C.P. 28-19	19.18	16.20	84.44	19.80	3.87	76.63	19.80	56.83
C.P. 29-320	18.13	15.75	86.89	21.20	3.77	79.92	21.20	58.72

Notes: Second Stubble—Harvesting dates: 12/9-10/33; 11/9-11/34 and 11/11/35. Planted October 8, 1932.

First Stubble—Harvesting dates: 11/9-11/34 and 11/11-13/35. Planted October 9, 1933.

Fall Plant—Harvested 12/5/35. Planted October 4, 1934.

The results of the Sterling second stubble tests indicate that Co. 290, C.P. 28-11, and C.P. 807 are the three leading varieties. C.P. 28-11 showed highest sucrose, followed by Co. 281 and Co. 290.

In the first stubble results, C.P. 28-19, C.P. 29-320, and C.P. 807 are the three leading varieties, while C.P. 28-19, C.P. 29-320, C.P. 28-11, and Co. 281 are highest in sucrose tests.

C.P. 29-320, C.P. 28-19, Co. 290, and C.P. 28-11 are the four leading fall plant cane varieties. From a sucrose standpoint, C.P. 28-19 is first, followed by C.P. 29-320, C.P. 28-11, and Co. 281.

TABLE 9—BILLEAUD TEST FIELDS

(Lintonia Silt Loam)

	———Normal Juice———			Tons Per	——Value——		Less $1	
Variety	Brix	Sucrose	Purity	Acre	Ton	Acre	Harvest	Balance
First Stubble								
P.O.J. 36	15.82	13.20	83.44	10.61	$3.22	$ 34.16	$10.61	$23.55
Co. 281	16.99	14.63	86.11	8.85	3.53	31.24	8.85	22.39
Co. 290	16.60	13.48	81.20	18.68	3.28	61.67	18.68	42.59
C.P. 807	14.85	12.15	81.82	16.68	3.07	51.21	16.68	34.53
C.P. 28-11	17.67	14.73	83.36	18.42	3.55	56.55	18.42	38.13
C.P. 28-19	18.06	15.68	86.82	9.33	3.75	34.99	9.33	25.66
C.P. 29-320	16.89	14.73	87.21	13.71	3.55	46.90	13.21	33.69
Fall Plant								
P.O.J. 36	16.73	13.46	80.45	21.90	3.28	71.83	21.90	49.93
Co. 281	17.50	14.95	85.43	23.80	3.60	85.68	23.80	61.88
Co. 290	17.21	13.61	79.08	36.20	3.31	119.82	36.20	83.62
C.P. 807	16.05	13.47	83.92	31.30	3.28	102.66	31.30	71.36
C.P. 28-11	16.92	13.36	78.96	26.25	3.25	85.31	26.25	59.06
C.P. 28-19	19.84	17.36	87.50	27.15	4.11	111.59	27.15	84.44
C.P. 29-320	17.60	14.53	82.56	26.25	3.51	92.14	26.25	65.89

Notes: First Stubble—Harvesting dates: 12/19-20/34 and 10/31/35. Planted October 10, 1933.

Fall Plant—Harvested 11/22/35. Planted September 28, 1934.

In the first stubble results of the Billeaud test field, Co. 290, C.P. 28-11, and C.P. 807 made the best showing. From a sucrose standpoint C.P. 28-19 was first, followed by C.P. 28-11, C.P. 29-320, and Co. 281.

The fall plant cane results indicate that C.P. 28-19, Co. 290, and C.P. 807 are the leading varieties. C.P. 28-19 was again highest in sucrose, followed by Co. 281 and C.P. 29-320.

Co. 290 was superior to C.P. 807 in both the first stubble and fall plant cane results.

Co. 281 was slightly outranked by P.O.J. 36 as first stubble, but in the fall plant cane tests it greatly outranked P.O.J. 36.

TABLE 10—YOUNGSVILLE TEST FIELDS
(Olivier Silt Loam)

Variety	Normal Juice			Tons Per Acre	Value		Less $1 Harvest	Balance
	Brix	Sucrose	Purity		Ton	Acre		
First Stubble								
P.O.J. 36	15.42	12.18	78.97	4.13	$3.07	$ 12.68	$ 4.13	$ 8.55
Co. 281	17.07	13.98	81.92	8.12	3.39	27.53	8.12	19.41
Co. 290	16.78	13.12	78.16	11.66	3.20	37.31	11.66	25.65
C.P. 807	15.62	12.57	80.45	11.39	3.09	35.20	11.39	23.81
C.P. 28-11	17.56	14.10	80.32	11.29	3.41	38.50	11.29	27.21
C.P. 28-19	17.46	14.61	83.65	12.60	3.52	44.35	12.60	31.75
C.P. 29-320	16.68	13.52	81.08	14.18	3.29	46.65	14.18	32.47
Fall Plant								
P.O.J. 36	15.91	12.92	81.19	17.75	3.16	56.09	17.75	38.34
Co. 281	17.75	15.15	85.34	22.05	3.64	80.26	22.05	58.21
Co. 290	16.68	12.81	76.77	39.10	3.14	122.77	39.10	83.67
C.P. 807	16.20	13.27	81.94	32.60	3.24	105.62	32.60	73.02
C.P. 28-11	18.43	15.02	81.49	25.55	3.61	92.24	25.55	66.69
C.P. 28-19	19.69	17.08	86.72	24.10	4.05	97.61	24.10	73.51
C.P. 29-320	17.07	14.00	82.04	25.85	3.39	87.63	25.85	61.78

Notes: First Stubble—Harvesting dates: 12/8-9/34 and 11/10/35. Planted October 12, 1933.

Fall Plant—Harvested 12/15/35. Planted October 15, 1934.

In the Youngsville test field results, C.P. 29-320, C.P. 28-19, and C.P. 28-11 are the leading first stubble varieties; while Co. 290, C.P. 28-19, and C.P. 807 are the leading fall plant cane varieties.

From the standpoint of highest sucrose, C.P. 28-19 was the leading variety in both first stubble and fall plant cane, followed by C.P. 28-11 and Co. 281 in the first stubble and by Co. 281 and C.P. 28-11 in the fall plant cane.

Co. 290 proved superior to C.P. 807 in both the first stubble and fall plant cane results.

Co. 281 was superior to P.O.J. 36 in both the first stubble and fall plant cane tests.

SUMMARY

The sugar cane test field work of the Louisiana Experiment Station was conducted on a basis similar to that of past years at ten locations in representative areas of the cane belt. The field and big mill analytical data on a total of twenty-seven test fields, consisting of fall plant, first and second stubble varieties, were obtained during the harvesting season of the 1935 crop.

The 1935 season was ideal for sugar cane in Louisiana. With the favorable weather conditions that prevailed throughout the year, the cane crop made an excellent growth in all of the sugar cane parishes. The weather was exceedingly good during the harvesting period.

The results of the three alluvial section test fields on "sandy land," at Cinclare, Glenwood, and Reserve, indicate that C.P. 28-19 gave the highest sucrose tests, followed by Co. 281, C.P. 29-320, and C.P. 28-11.

Co. 290, C.P. 28-19, C.P. 29-320, and C.P. 28-11 were the leading varieties at these three test fields. Co. 290, which gave the highest field yields, was comparatively low in sucrose tests, being slightly below standard cane (11.5%) in three out of nine tests. This variety, according to our previous recommendation, should be grown on lands that are known to produce good or satisfactory sucrose yields.

The results of the Red River section at Meeker and Bunkie indicate that C.P. 29-320 is the outstanding variety. C.P. 28-19, Co. 281 and C.P. 28-11 are next in importance, giving good results as plant cane and stubble. P.O.J. 234 made its best showing at Bunkie, comparing favorably with Co. 281.

Both Co. 290 and C.P. 807 proved to be very dangerous canes for the Bunkie-Meeker area, giving low sucrose tests as stubble and being entirely on a "salvage cane" basis as plant cane. These two varieties are not recommended for commercial field planting in this northern area.

The Bubenzer first and second stubble results indicate that Co. 281, P.O.J. 234, P.O.J. 36, and P.O.J. 213 are the most important varieties from the standpoint of highest calculated gallons of syrup per ton yield; of the plant cane, C.P. 28-11, Co. 290, C.P. 29-320, and Co. 281 were the leading varieties. In highest calculated syrup per acre yields from plant cane and first stubble, Co. 290, C.P. 29-320, C.P. 28-19, and C.P. 28-11 were the ranking varieties.

The results of test fields on soils of the Teche section near Franklin indicate that C.P. 28-19, C.P. 29-320, Co. 290, and C.P. 28-11 are the leading varieties as plant cane and stubble. C.P. 28-19, C.P. 29-320, C.P. 28-11, and Co. 281 are the four leading varieties from the standpoint of high sucrose tests.

In the Jeanerette area on three fields that received practically no cultivation, C.P. 29-320 was the outstanding variety as fall plant cane and first stubble, while C.P. 28-19 was the leading second stubble variety.

The results on Lintonia silt loam of the western section show that Co. 290, C.P. 28-11, and C.P. 807 were the leading first stubble varieties, and C.P. 28-19, Co. 290, and C.P. 807 were the leading plant cane varieties.

At Youngsville on Lintonia silt loam, C.P. 29-320, C.P. 28-19, and C.P. 28-11 made the best showing as first stubble, and Co. 290, C.P. 28-19 and C.P. 28-11 were leading plant cane varieties.

At both Broussard and Youngsville, Co. 290 proved definitely superior to C.P. 807 as stubble and plant cane. At both places C.P. 28-19 was the leading variety from a sucrose standpoint, followed by Co. 281, C.P. 28-11, and C.P. 29-320.

The results of fall plant cane and first stubble tests of all test fields definitely indicate that C.P. 28-19 has given the highest sucrose tests, with the next four varieties in the following order: C.P. 29-320, P.O.J. 234, Co. 281, and C.P. 28-11.

The three recently released varieties, C.P. 28-11, C.P. 28-19, and C.P. 29-320, are early maturing and under favorable conditions are capable of producing good field yields as plant cane and stubble. C.P. 28-19 and C.P. 29-320 are definitely good land canes, while C.P. 28-11 is well suited to black lands. C.P. 28-11 is very susceptible to cane borers and wind-storm damages, while on the other hand it is very resistant to stubble deterioration, red rot, and mosaic diseases. It can be used very advantageously to replace C.P. 807 on the heavier poorly drained soils.

On very fertile soils C.P. 28-19 will lodge, while C.P. 29-320 is very erect growing and not subject to lodging. Both C.P. 28-19 and C.P. 29-320, like Co. 281, respond well to good cultivation. During the early spring at the proper time the dirt should be carefully removed from the plant cane to facilitate germination and insure good stands.

The Co. 281 variety is one of our most valuable commercial field canes. Although it is a little later maturing than P.O.J. 234, it has consistently been equally as good from a sucrose standpoint, and has given higher field yields as plant cane and stubble. This variety is best adapted to the fertile soils and responds well to good cultivation. Co. 281 is an excellent cane for mill windrowing, being superior to all other varieties. From this important standpoint, it should be planted for late milling as a safeguard against early bud-killing freezes. When this cane has attained a satisfactory sucrose content, windrowing before severe freezes is most important and advantageous.

The Co. 290 variety has greatly surpassed C.P. 807 at all test fields as fall plant cane and stubble, giving best results in the Teche and western sections and on the heavy mixed and black lands of the lower Mississippi River section. It has been low in sucrose yields in the upper Mississippi River and Red River sections. The Experiment Station recommendation for planting this variety on lands that are of *moderate fertility* should be closely observed.

Co. 290 produces excellent field yields as plant cane and stubble and matures about mid-season. It is economical to cultivate, harvest, and mill. Co. 290 responds well to fall planting and should never be planted in the spring.

The matter of planting a well balanced fall planting program and utilizing the varieties that will give the best response on the different soil types is of vital importance to all cane growers. It is not advisable or safe to plant too large a proportion of Co. 290, a mid-season cane which under early severe freeze conditions would very probably result in serious losses. The planting program should be balanced to include a sufficient amount of Co. 281 to provide the necessary insurance against early freezes, and to have sufficient early maturing varieties like C.P. 28-11, C.P. 28-19, and C.P. 29-320 to assure an early start of the milling operations.

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U. S. Department of Agriculture Weather Bureau.

Sugar Cane Variety Report

FOR THE SEASON 1935

LOUISIANA SUGAR EXPERIMENT STATION

By E. C. Simon*

Fiber determinations were made during the 1935 grinding season on plant and stubble cane of the newer commercial varieties.

Variety	Average Fiber Content
Co. 290	10.00%
Co. 281	12.50%
C.P. 29-320	13.00%
C.P. 28-19	14.00%
C.P. 807	14.50%
C.P. 28-11	15.00%

MATURITY STUDIES

In tables I and II there are given comparable analyses showing the relative maturity of plant cane and first year stubble of the newer varieties, under the favorable conditions obtaining for maturity during the 1935 harvesting season.

The analyses presented in the tables bear out data obtained over a period of several years which indicate that the varieties C.P. 28-19 and C.P. 29-320 are very early maturing canes. At Baton Rouge C.P. 29-320 has consistently been much earlier in maturity than P.O.J. 234, while C.P. 28-19 has been as early. In the series of analyses for the 1935 season both C.P. 28-19 and C.P. 29-320 were earlier in maturity and gave juices containing higher sucrose than P.O.J. 234.

Here again, as in the past, Co. 281 shows itself to be somewhat late in maturity, this despite the very favorable season that obtained for early maturity during 1935. In the planting set-up it is necessary to take this fact into consideration.

Only through a proper appreciation of the qualities of the several varieties can the planter utilize them so as to secure the best returns from his crop throughout the entire grinding season. The planter must bear in mind that it is necessary to plant enough Co. 281 to enable him to windrow a sufficient portion of his crop for late grinding as a precaution against cold damage. He must also bear in mind that it is just as important and necessary to include enough of some or all of the varieties—C.P. 28-11, C.P. 28-19, and C.P. 29-320—in his plantings to insure a supply of cane of standard quality for the first weeks of the grinding season.

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* Analytical work by Mr. E. J. Coons, Louisiana Sugar Experiment Station Chemist, 1935-36 season.

TABLE I
MATURITY STUDIES OF PLANT CANE—1935

	P.O.J. 234				C.P. 28-19				C.P. 28-11			
Date	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
10/ 2	14.35	10.22	71.22	70.65%	14.15	9.77	69.05	67.44%	13.70	9.14	66.72	65.61%
10/15	15.20	11.56	76.05		15.65	11.81	75.46		15.40	10.81	70.19	
11/ 1	18.00	14.68	81.56		17.90	14.45	80.73		16.75	12.42	74.15	
11/18	16.95	14.00	82.60		18.30	15.15	82.79		17.30	13.46	77.80	
12/ 3	18.10	15.12	83.54		19.00	15.98	84.11		18.30	14.16	77.38	

	C.P. 29-320				Co. 281				Co. 290			
Date	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
10/ 2	14.80	10.77	72.77	68.26%	11.15	6.45	57.85	70.37%	13.50	9.42	69.78	72.01%
10/15	15.55	11.76	75.63		13.70	9.55	69.71		14.40	10.20	70.83	
11/ 1	17.35	13.86	79.88		15.25	11.44	75.02		15.85	11.83	74.64	
11/18	17.40	14.11	81.09		15.70	12.33	78.54		16.80	13.49	80.30	
12/ 2	18.10	14.81	81.82		16.15	12.63	78.20		17.20	13.63	79.24	

TABLE II
MATURITY STUDIES OF FIRST YEAR STUBBLE CANE—1935

		P.O.J. 234				C.P. 28-19				C.P. 28-11		
Date	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
10/ 2	15.30	11.69	76.41	69.81%	17.00	13.74	80.82	65.36%	15.55	11.58	74.47	66.56%
10/15	16.10	12.76	79.25		18.05	15.01	83.16		16.30	12.40	76.07	
11/ 1	17.40	14.19	81.55		19.45	16.54	84.99		18.00	14.28	79.33	
11/18	18.30	15.95	87.16		19.90	17.44	87.64		18.60	15.73	84.57	
12/ 2	18.50	15.99	86.43		20.15	17.52	86.95		19.00	15.65	82.37	
		C.P. 29-320				Co. 281				Co. 290		
Date	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
10/ 2	16.60	13.32	80.24	67.21%	13.90	10.19	73.31	68.69%	14.20	10.54	74.23	71.01%
10/15	17.25	14.07	81.57		15.80	12.69	80.32		15.00	11.34	75.60	
11/ 1	18.35	15.14	82.51		16.50	13.30	80.61		17.25	13.95	80.87	
11/18	19.60	16.99	86.68		17.90	15.19	84.86		17.90	14.81	82.74	
12/ 2	19.80	17.15	86.62		19.20	16.63	86.61		17.90	14.50	81.01	

TABLE III

Comparison of Commercial Varieties

1935 Season

	Plant Cane—Harvested 12/6/35			First Year Stubble—Harvested 11/5/35			Second Year Stubble—Harvested 10/28/35		
Variety	96° Sugar Per Ton Cane	Tons Cane Per Acre	96° Sugar Per Acre	96° Sugar Per Ton Cane	Tons Cane Per Acre	96° Sugar Per Acre	96° Sugar Per Ton Cane	Tons Cane Per Acre	96° Sugar Per Acre
P.O.J. 234	179.61	27.52	4943.	210.71	19.57	4124.	194.50	14.44	2809.
Co. 281	170.55	33.76	5758.	203.87	23.30	4750.	168.60	31.44	5301.
C.P. 28-11	163.02	36.08	5882.	189.48	26.03	4932.	161.46	30.75	4965.
C.P. 28-19	211.65	35.50	7514.	216.95	30.56	6630.	191.27	29.58	5658.
C.P. 29-320	191.65	35.10	6727.	223.32	25.63	5724.	*	*	*
Co. 290	179.82	48.32	8689.	201.34	30.46	6133.	187.21	30.64	5736.
C.P. 807	168.23	38.55	6485.	174.76	41.53	7258.	157.23	29.04	4566.

96° sugar per ton of cane calculated by Deere formula, using a B.H.E. of 97 per cent, and using actual extraction figures obtained on Experiment Station mill. For comparative data on the milling of the above varieties on a large mill scale see Test Field data presented in the first part of this bulletin.

Discussion

The comparative figures in the above table show that P.O.J. 234 is definitely inferior to the newer commercial varieties.

The sugar per acre yields of the second year stubbles of the varieties Co. 281, C.P. 28-11, C.P. 28-19, and Co. 290 are greater than the sugar per acre yield from the plant cane of P.O.J. 234. C.P. 29-320 second year stubble was used for "seed" and no actual weights of mill cane were secured; however, this stubble was estimated to yield a slightly heavier tonnage than Co. 281.

The excellent stubbling qualities of the newer varieties are clearly shown by a comparison of the yields in sugar per acre obtained from second year stubble and first year stubble.

TABLE IV

Windrowing Experiment

Temperature Record in Degrees F.

1935	11/23	11/24	12/2	12/3	12/13	12/14	12/20	12/21	12/22	12/23	12/25	12/26	12/27	12/30
Minimum temperature	30	31	30	27	30	32	28	25	31	28	30	28	23	30
Maximum temperature	53	60	56	59	64	68	46	41	45	67	58	42	46	50
Hours below 32° F.	5	4	2	9	3	1	1	9	3	9	3	8	9	6

In table IV is given the minimum and maximum temperatures for those days during which this experiment was conducted in the 1935-36 grinding season on which the temperature was 32° F. or lower.

Table IV shows that on November 23 and 24 there were minimum temperatures of 30° F. and 31° F., respectively, with a total of 9 hours of weather below 32° F. Due to this cold weather, a few of the buds and some of the eyes on standing cane were killed.

The next cold weather, as shown in table IV, was on December 2 and 3. This resulted in the killing of most of the buds and many of the eyes on standing cane. There was, however, quite a great deal of green left in the standing cane. Examination of the inside of the stalks showed few signs of cold damage to the cellular tissues. While acidity was higher than normal, all juices filtered well in the laboratory and had their natural green color and appearance.

On December 5 a windrowed experiment was begun in order to compare the keeping qualities of our newer varieties with the standard mill-windrowing variety, Co. 281. Comparable analyses of windrowed and standing cane are given in table V. This shows the relative performance of the varieties from December 5, 1935, to January 6, 1936.

The term "deterioration" is used to designate the loss of sucrose content as indicated by juice analyses, and has no reference to the quality of the juice from the standpoint of its physical appearance or workability in the factory.

DISCUSSION

Until December 20, 1935, standing cane of all varieties was in very good condition. The acidity had increased somewhat but juice analyses indicated that little deterioration had taken place.

Between December 20, 1935, and January 6, 1936, standing cane deteriorated rapidly. A study of the weather records for this period shows that temperatures went to as low as 23° F., and that there were seven freezes of from 3 to 9 hours duration. The effect of such severe cold weather was quite apparent, resulting in the breaking down of cellular tissues on the inside of stalks and in a great drop in sucrose content in the case of all varieties. The juices extracted from standing cane were viscous, contained some gas, had lost their natural green color, and had become full of decomposition products. The standing cane of the varieties Co. 281, Co. 290, and C.P. 807 showed the greatest drop in the sucrose content of their juices, while the varieties C.P. 29-320, C.P. 28-19, and C.P. 28-11 showed the least.

In the case of the windrowed cane, Co. 281, our standard windrowing variety, lost but little sucrose by deterioration during the entire period of the experiment, and was in a fairly good physical condition on January 6, 1936, when the test was terminated. All other varieties lost sucrose rapidly, and while they were in as good or better condition from a standpoint of physical appearance, none compared with Co. 281 from a mill-windrowing standpoint when sucrose losses are considered. The varieties C.P. 28-11 and C.P. 807 showed the greatest sucrose losses through deterioration, and were followed by C.P. 28-19, Co. 290, and C.P. 29-320.

On January 6, 1936, the juices from windrowed cane of all varieties could be

TABLE V

Windrowing Test—1935-36

Plant Cane

Variety	Date	STANDING Brix	STANDING Sucrose	STANDING Purity	STANDING Extraction	STANDING Acidity	WINDROWED Brix	WINDROWED Sucrose	WINDROWED Purity	WINDROWED Extraction	WINDROWED Acidity
Co. 281	12/ 5/35	16.90	13.88	82.13	69.00%	2.8 cc.	16.90	13.88	82.13	69.31%	2.8 cc.
	12/13/35	16.60	13.17	79.34		3.0 cc.	16.85	12.82	76.08		3.1 cc.
	12/20/35	16.50	12.72	77.09		3.8 cc.	17.40	12.87	73.97		4.4 cc.
	1/ 6/36	14.70	8.50	57.82		6.5 cc.	16.90	13.05	77.22		3.4 cc.
Co. 290	12/ 5/35	17.50	14.16	80.91	68.61%	3.0 cc.	17.50	14.16	80.91	70.58%	3.0 cc.
	12/13/35	17.50	13.68	78.17		3.2 cc.	18.30	13.17	71.97		3.2 cc.
	12/20/35	18.40	14.93	81.14		3.3 cc.	18.30	13.48	73.66		3.4 cc.
	1/ 6/36	15.60	10.00	64.10		6.5 cc.	18.05	11.98	66.37		3.1 cc.
C.P. 29-320	12/ 5/35	17.65	14.28	80.91	65.48%	3.0 cc.	17.65	14.28	80.91	66.71%	3.0 cc.
	12/13/35	18.00	14.76	82.00		2.8 cc.	18.10	13.96	77.13		3.0 cc.
	12/20/35	18.50	15.16	81.95		3.0 cc.	19.50	13.47	69.08		3.4 cc.
	1/ 6/36	15.60	12.00	76.92		4.2 cc.	18.50	12.68	68.54		3.2 cc.
C.P. 28-19	12/ 5/35	19.10	16.28	85.24	65.95%	2.3 cc.	19.10	16.28	85.24	63.81%	2.3 cc.
	12/13/35	19.30	16.58	85.91		3.0 cc.	20.30	15.00	73.89		3.4 cc.
	12/20/35	18.70	15.38	82.25		3.1 cc.	19.90	14.72	73.97		2.9 cc.
	1/ 6/36	17.05	13.00	76.25		4.9 cc.	19.90	13.20	66.33		3.5 cc.
C.P. 28-11	12/ 5/35	18.30	14.78	80.77	63.80%	3.9 cc.	18.30	14.78	80.77	64.65%	3.9 cc.
	12/13/35	18.55	14.56	78.49		4.9 cc.	18.15	11.01	60.66		4.2 cc.
	12/20/35	18.90	15.02	79.47		4.1 cc.	18.70	7.97	42.62		4.4 cc.
	1/ 6/36	17.75	12.87	72.51		4.7 cc.	18.45	10.06	54.53		4.5 cc.
C.P. 807	12/ 5/35	15.70	12.49	79.55	62.03%	2.5 cc.	15.70	12.49	79.55	63.82%	2.5 cc.
	12/13/35	16.40	13.37	81.52		2.1 cc.	16.60	10.54	63.49		3.1 cc.
	12/20/35	15.60	12.10	77.56		2.9 cc.	17.50	9.68	55.31		3.3 cc.
	1/ 6/36	12.60	8.00	63.49		5.3 cc.	17.30	7.51	43.41		3.6 cc.

handled satisfactorily in the laboratory by the usual routine methods of analysis, although stalk examinations and the appearance of the juices indicated cellular breakdown. In the case of standing cane, only the juices from C.P. 28-11 and C.P. 29-320 could be satisfactorily handled in this manner.

The findings from this investigation confirm work done previously to the effect that it is necessary to grow a sufficient acreage of sugar cane which will stand windrowing if the grinding season is to be continued with safety after December 20.

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Comparison of Management Methods for Chicks, Layers, and Breeding Hens

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Comparison of Management Methods for Chicks, Layers, and Breeding Hens

INTRODUCTION

The control of mortality is an ever present problem of the poultryman. Varied methods of management have been and are being used by poultrymen in attempts to control it. Parasites and diseases are difficult to control in Louisiana because of mild winter weather and rather heavy rainfall. Certain parts of the state have the additional problem of low, heavy, poorly drained soil which makes it very difficult to maintain sanitary yards or ranges, particularly with relatively large flocks. These conditions prompted the present experiments which were started in 1930.

REVIEW OF LITERATURE

Charles and Knandel (1928) were among the first to report extensive experiments in which chicks were grown successfully to maturity in confinement (kept off the ground entirely). Knandel, Callenbach and Margolf (1930) in later work at the same station obtained satisfactory results in growing chicks and housing layers and breeders under conditions of confinement. They state, however: "The confinement method of rearing chicks is not advocated except where poultrymen have experienced great difficulty in rearing chicks on range, owing to roundworm and tapeworm infestations. Perhaps a modification of the confinement method, using free range part of the year, may be a better plan under some circumstances." Kennard and Bethke (1929) give a discussion of problems involved in keeping chickens in confinement. As a practical plan for certain poultrymen they suggest brooding the chicks indoors, growing the pullets on a rotated range and keeping the layers in confinement. Kennard and Chamberlin (1933) report recent work in which growth rate of battery grown and range grown pullets is compared, and egg production of caged (laying battery) versus house layers is given. These investigators do not draw definite conclusions but express the belief that batteries . . . "will find their place as one of the standard methods of managing the layers, prospective breeders, egg laying contest, and for market egg production." Kennard and Chamberlin (1934a and 1934b) report further experiments in which a comparison is made of the growth and egg production of pullets reared on contaminated range, on fresh range, and in confinement. Again final conclusions are withheld but the statement is made that pullets grown in confinement should be protected subsequently against the hazards of contaminated yards or ranges. The closing paragraph of the (1934b) report is well worth quoting. "These four years' results and experiences under varying conditions have demonstrated that the behavior and performance of pullet layers are definitely influenced by their management as chicks and growing pullets. However, management in itself had its limitations and all managements tested failed to prevent or control some of the most serious causes of mortality, such as paralysis and cholera-like diseases. For their prevention and control, we believe that special breeding, selection, feeding, and management for the development of birds resistant or immune to such complications offer the best promise for the final solution of the problem."

Feed consumption and rate of growth of chicks grown in confinement are given by Hendrick and co-workers (1929) and Bice (1931) and similar data for battery grown chicks are given by Platt (1934) and Buckner and co-workers (1934). In recent years many reports have been made of feeding trials in which the chicks were battery brooded.

Buckner, Martin, and Insko (1934) conducted an experiment for one year in which one lot (120 chicks) was started in a battery brooder and another was grown in batteries to 22 weeks of age, when all lots were transferred to similar colony houses with blue grass yards. They found no appreciable differences in rates of growth but mortality was greater, egg size smaller, and egg production was lower for the battery grown pullets.

Godfrew and Titus (1934) made a comparison of confinement versus limited range for laying stock. They conclude that confined birds that receive cod liver oil and sunshine lay as many eggs and slightly larger eggs than birds that have access to a limited range. When cod liver oil was omitted the confined birds laid fewer and smaller eggs.

Kennard and Chamberlin (1934c) discuss the results of nine tests which extended over a period of 10 years, with layers on range versus those in confinement. These authors make the following statements: "All of the tests, with one exception, showed no significant difference in the rate of mortality between the confined layers which received a complete ration and those on a good range. . . . While the range method appears advantageous for comparatively small flocks under farm conditions . . . , the procedure has many practical limitations.

"When the number of layers is such as to preclude the practicability of providing a good range and where it is not desired to confine the birds indoors, the best solution of the problem would seem to be the cinder yard or wire sun porch. . . . The good range procedure has its practical limitations so that larger scale poultrymen are generally obliged to keep their layers confined."

The first egg laying contest in laying batteries is reported by Sipe and Sykes (1934). Callenbach and Knandel (1935) report rather extensive tests in which Barred Plymouth Rocks and S. C. W. Leghorns were kept in hen batteries. The egg production and the mortality of the battery groups were practically the same as for the laying house groups.

PLAN OF THE EXPERIMENT

This experiment was started on March 1, 1930, and terminated June 30, 1933, except for lot 6 which was continued to June 1, 1935.

Six lots of chicks were grown under various conditions and the pullets were subsequently subjected to different methods of management. The original plan was to repeat this procedure for four years but unforeseen circumstances caused some changes to be made and the experiment to be terminated a year sooner than had been planned.

Lot 1 chicks were brooded and grown to maturity in wire-floored runs with sunporch in 1930 and 1931. They were brooded four weeks in electric battery brooders in 1932 and 1933, then transferred and grown to maturity in wire-floored runs with a fly-screened, wire-floored sunporch available. The laying pullets were confined to a section (12′×18′) of the laying house with wire floor and with access to a wire-floored fly-screened sunporch.

Lot 2 chicks were brooded for the first two years on wire floors and for the latter two years in batteries until four weeks of age. All four years they were transferred at this age and grown to maturity in runs with concrete floor, with shavings for litter, and with access to a sunporch with concrete floor. The sunporch was scrubbed normally twice per week and more often when coccidiosis was noted. The laying pullets were confined to a section of the laying house as in lot 1 with shavings litter on a wood floor. For the first two years of the test the pullets had access to a fly-screened wire-floored sunporch, while for the third year the sunporch was replaced by a fly-screened cinder court.

Lot 3 chicks were brooded on wire floors for twelve weeks during the 1930 and 1931 seasons and in batteries for twelve weeks for the two following seasons. The pullets were then transferred directly to a third section of the laying house. They were grown and housed as layers in this house with shavings for litter and with access at all times to one of alternated double yards in which a green feed crop was growing.

Lot 4 chicks were started and brooded for twelve weeks on a concrete floor with rice bran for litter at the start, later replaced with shavings. An electric colony brooder supplied the heat for this lot. After a few weeks of age the chicks had access to a concrete run as in lot 2. When twelve weeks of age these pullets were transferred to one division of a three-year-rotated growing range and housed in summer shelters until mature. At about the time laying started the pullets were moved to a fourth section of the laying house and managed the same as lot 3.

For the first two years of the experiment lot 5 chicks were brooded and grown to maturity in wire-floored runs without a sunporch. The mature pullets were confined to a fifth section of the laying house with wire floor but without access to a sunporch.

For the third and fourth year tests, lot 5 chicks were brooded in batteries for four weeks and then grown to twelve weeks in wire-floored runs with access to a fly-screened, wire-floored sunporch. At twelve weeks of age they were moved to a three-year-rotated growing range and housed in summer shelters until mature. The pullets were then placed in a wire-floored section of the laying house but were given access to alternated double yards (as in lots 3 and 4).

For the first two years of the experiment lot 6 chicks and layers were managed the same as lot 2 birds, except that no sunporches were available at any time. For the third experimental year (in which all lots were run) and for two additional years during which this lot alone was continued, lot 6 was managed as described below. During the latter three years, 1932 to 1935, all lot 6 chicks (except one group) were brooded and grown to maturity in batteries, and transferred to individual laying cages.

To test the reproductive ability of females grown and housed under the various conditions as outlined, it was planned to reproduce the pullets for each lot for a given year from the layers in the same lot the previous year. This plan was followed in general, but it was necessary to supply birds from other sources in a few cases due to poor hatchability and to excessive mortality in some lots.

The chicks were all pedigree hatched and the females were weighed individually when day old and at two week intervals until twelve weeks of age and at four week intervals thereafter until sexually mature. The birds were weighed individually on the first day of each month during the laying year. They were trapnested and an adequate sample of eggs was weighed to determine average egg size. Records of mortality of chicks and of hens were maintained and the hatchability of eggs was determined for each lot.

All lots of chicks were given similar care and the same adequate diet and the laying pullets were fed and cared for alike except for the differences in management described. During the two years that lot 6 alone was continued the rations of the caged layers differed from those fed during the first three years of the experiment.

RESULTS

GROWTH AND VIABILITY OF CHICKS

The average weights of the chicks at various ages and the per cent of the female chicks kept are given in Tables 1, 2, and 3.

TABLE 1

BODY WEIGHT AND VIABILITY OF FEMALE CHICKS—HATCHED IN 1930. (MARCH 29)

Lot No.	Management	Body Weight in Grams by Weeks					No. Females Mature	Per Cent of Females Kept* (20 Weeks)
		D. Old	2	4	12	20		
1	On wire floor throughout screened sunporch	38.7	78.0	148.0	617.0	998.0	29	41.4
2	On wire floor 4 weeks then litter and sunporch throughout	38.3	80.9	153.0	599.0	1001.0	28	40.0
3	On wire floor 12 weeks then to laying houses double yards	38.4	81.5	146.0	635.0	929.0	40	57.1
4	On litter 12 weeks—rotated growing range	38.7	64.9	112.0	529.0	966.0	21	30.0
5	On wire floor throughout—no sunporch	38.1	78.5	144.0	651.0	1040.0	17	24.3
6	On wire 4 weeks, then litter throughout—no sunporch	40.2	85.0	164.0	635.0	1007.0	22	31.4

* This is not a measure of viability alone, because undesirable pullets disposed of are also excluded.

The chicks grown during the 1930 and 1931 seasons were severely handicapped in all lots due to unsatisfactory brooding facilities. Growth rate and viability were distinctly subnormal for the 1930 season as shown in Table 1. Mortality was so great in all lots (at an early age) for the 1931 season that the data are not included in this report. Chicks in lot 4, brooded on litter, averaged lightest in weight at two weeks, four weeks, and twelve weeks of age, but the females kept at twenty weeks of age were slightly larger than those in lot 3 (moved to the laying house at twelve weeks of age); however, they averaged somewhat below those of the other lots at this age. The per cent of the pullets kept was highest in lot 3 and lowest in lot 5.

In 1932 (Table 2) two series of chicks were hatched for each lot, the first on March 22 and the second on May 3. The average weights are given separately for the two series because at eight and at twelve weeks of age the chicks of the earlier hatched series (A) were heavier in each case. The difference in weight at eight weeks was great enough to be significant in four of the six lots (Chi square test). Only in lot 1, however, did this difference persist at twenty-four weeks of age. The variability in weight (or unevenness of growth), as measured by the standard deviation of the mean at twenty-four weeks of age, was greater for series B in five of the six lots. The series B birds of lots 3 and 4 were particularly variable in size.

TABLE 2

Body Weight and Viability of Female Chicks—Hatched in 1932

Management	Date Hatched	Lot No.	Series	Body Weights in Grams by Weeks											Per Cent of Females Kept		
				Day Old	S. D. M. Day Old	2	4	8	S. D. M. 8 Weeks	12	20	No. Females Mat. (24 Wks.)	24	S. D. M. 24 Weeks	4	12	20
Battery 4 weeks then wire floor sunporch throughout	3/22	1	A	33.9	1.07	92.6	199.2	497.0	14.7	797.0	1171.0	21	1298.0	34.0	100.0	89.3	78.6
	5/3	1	B	35.0	.74	85.0	183.7	360.5	12.3	651.0	1067.0	15	1151.0	30.6	87.5	53.1	46.9
Battery 4 weeks then litter sunporch throughout	3/22	2	A	32.9	1.20	91.0	198.8	500.0	20.8	827.0	1250.0	12	1397.0	39.9	78.3	65.2	56.5
	5/3	2	B	34.8	.72	89.2	199.2	464.4	20.8	757.0	1282.0	18	1389.0	40.9	76.0	76.0	72.0
Battery 12 weeks then laying house —double yards	3/22	3	A	33.6	.93	100.9	217.1	498.9	14.2	805.0	1027.0	14	1146.0	34.2	92.0	92.0	76.0
	5/3	3	B	34.6	.49	83.3	175.8	379.3	19.7	675.0	1098.0	10	1290.0	74.6	91.3	73.9	43.5
Litter 12 weeks then to rotated growing range	3/22	4	A	35.1	1.07	90.6	191.2	461.3	25.3	759.0	1047.0	14	1209.0	41.5	82.1	57.1	57.1
	5/3	4	B	38.3	1.13	91.6	169.8	400.2	26.9	714.0	1112.0	9	1312.0	92.3	73.3	46.7	33.3
Battery 4 weeks—wire floor to 12 weeks then to range	3/22	5	A	34.2	.94	100.4	205.4	535.6	20.3	840.0	1138.0	17	1283.0	37.1	95.7	87.0	78.3
	5/3	5	B	35.6	.82	87.5	169.9	397.5	19.2	665.0	1056.0	14	1247.0	40.9	88.9	63.0	55.6
Battery throughout	3/22	6	A	31.2	.61	86.7	188.0	502.7	17.9	791.0	1185.0	15	1255.0	31.9	72.0	68.0	60.0
	5/3	6	B	34.0	.56	90.4	181.0	355.6	11.1	605.0	1269.0	19	1331.0	36.9	100.0	75.9	65.0

TABLE 3

Body Weight and Viability of Female Chicks—Hatched in 1933

Management	Date Hatched	Lot No.	Series	Body Weights in Grams by Weeks									Per Cent of Females Kept		
				Day Old	2	4	8	12	16	S. D. M. 16 Weeks	No. Females at 16 Weeks	25	4 Weeks	12 Weeks	16 Weeks
Battery 4 weeks then wire floor—sunporch throughout	3/6	1	A	35.0	101.2	206.5	508.2	809.0	1049.0	36.2	15		70.8	70.8	62.5
	4/3	1	B	Chicksof this lot sold by mistake									66.7	......	......
Battery 4 weeks then litter—sunporch throughout	3/6	2	A	33.8	96.3	195.1	445.0	739.0	948.0	21.4	22		100.0	75.9	75.9
	4/3	2	B	44.3*	91.8	154.3	392.0	679.0	......	......	......		94.1	88.2	......
Battery 12 weeks then laying house—double yards	3/6	3	A	34.8	101.0	196.3	508.6	780.0	1030.0	27.6	37		95.1	92.7	90.2
	4/3	3	B	44.5	96.5	134.0	379.0	630.0	......	......	......		80.0	40.0	......
Litter 12 weeks then to rotated growing range	3/6	4	A	37.3	100.9	148.5	418.1	717.0	997.0	21.5	21		52.6	38.6	36.8
	4/3	4	B	43.1	89.7	164.3	439.1	694.0	......	......	......		75.0	58.3	......
Battery 4 weeks—wire floors to 12 weeks then to rotated range	3/6	5	A	36.4	88.0	191.3	496.6	776.0	1072.0	14.5	29		87.2	74.0	74.4
	4/3	5	B	42.7	90.3	206.7	553.6	853.0	......	......	......		......	......	......
Battery throughout	3/6	6	A	35.5	90.3	191.0	512.9	809.0	1064.0	23.3	14	1303.0	75.0	70.0	70.0
	4/3	6	B	41.4	86.8	174.7	483.6	773.0	1023.0	......	11	1300.0	81.3	68.8	

* Series B chicks were 3 days old at first weighing.

These data indicate that later hatched pullets tend to vary more in rate of growth than do early hatched pullets, particularly under certain conditions of management. Lot 2 pullets were heaviest at twenty-four weeks of age while those of lots 3 and 1 averaged lightest in weight.

The per cent of pullets kept is considered separately for corresponding lots of the two series, since a Chi square test revealed differences in two of the pairs of lots at twenty weeks of age with other differences bordering on significance. The viability at four weeks of age was somewhat lower for lots 2 and 4, with the other lots uniformly good. The mortality was the highest in lot 4 (on litter from start) at twelve weeks, due to a severe outbreak of coccidiosis in this lot. Lot 2, placed on litter at four weeks, also suffered high mortality due to this disease. At twenty weeks of age mortality (plus culling out of inferior birds) was appreciably higher in the later hatch in four of the six lots. In series A viability was higher in lots 1, 3, and 5, while in series B it was higher in lots 2 and 6. Thus in all cases (except lot 2, series B) the chicks that were brooded for twelve weeks in batteries or on wire floors lived and developed better.

Two series of chicks were hatched in 1933 also, the first on March 6, the second on April 3 (See Table 3).

No chicks were weighed after July 1 except those in lot 6, because the remainder of the project was discontinued on that date. For this reason weights and viability could not be tabulated for series B chicks after twelve weeks of age. Lot 4, brooded on litter throughout, and lot 2, on litter at four weeks of age, were lightest in weight at four weeks of age and continued to average lighter at sixteen weeks, although the differences were not so great at this age. Growth in the other lots was quite similar. The most uniform growth occurred in lot 5, brooded on wire until twelve weeks of age and then grown out on a rotated range.

The survival of females in lot 4 was lowest at four, twelve, and sixteen weeks. It was highest at twelve weeks in lot 3 of series A, but for series B the mortality after twelve weeks was high in this lot, indicating that the later hatched pullets were handicapped when grown in yards used by mature birds. The high mortality in lot 4 was due chiefly to a severe outbreak of coccidiosis. Three years out of four the lot which was started on litter suffered from serious attacks of this disease.

RESULTS WITH MATURE BIRDS

The results with mature birds are presented in Tables 4 and 5. Summary records of mortality, body weight, egg production, egg size, feed consumption, and hatchability are included.

1930-1931 TEST

During the first year of these experiments laying house mortality was relatively high in all lots. It was highest in lot 3, which had been kept after twelve weeks of age in a laying pen. This lot had access to alternated double yards with green feed available. Mortality was also high in lot 6, confined to the house without sunporch. Four of the twelve deaths in this house were due to cannibalism. Viability was quite uniform in the other lots.

Body weight on October 1 was uniform for all lots except lot 3, in which the birds averaged about one-quarter of a pound lighter. Average size (weight) for the year was similar for all lots, although lot 4 birds averaged heaviest and lot 6 birds lightest in weight.

Egg production for nine months was highest for lot 4, with alternated yards (129.7 eggs), and lowest in lot 2, confined on litter (87.6 eggs). No great difference

TABLE 4

Results with Mature Birds 1930-1932

Lot No.	Management During Growth	Management as Layers	No. in Lot	Mortality and Culled	Body Weight		Eggs per Bird	Average Egg Weight (in Grams)	Feed Consumption		Hatching Record		Per Cent Hatch of Fertile Eggs
					Average for October 1	Average for Exp. Year			Average per Bird Per Doz.	Eggs Produced	Number Fertile Eggs Set	Per Cent Fertility	
					October 1, 1930 to June 30, 1931 (9 months)								
1	Wire floor—4 weeks, then screened sunporch, then litter	Wire floor—screened sunporch	19	36.8	1385	1454	113.2	54.5	69.1	7.3	353	74.9	29.2
2	On wire floor 4 weeks, then screened sunporch, then to laying house	On litter—screened sunporch	21	33.3	1311	1410	87.6	53.5	54.9	7.5	267	68.5	42.7
3	On wire 12 weeks, then laying yards rotated	On litter—double yards	23	60.8	1198	1411	109.6	53.1	62.7	6.9	320	68.3	54.0
4	On litter 12 weeks, then rotated growing range	On litter—double yards	18	38.8	1308	1486	129.7	53.3	55.8	5.2	505	69.3	62.5
5	Wire floor—no sunporch, then litter	Wire floor—confined to house	17	30.0	1290	1464	109.0	53.9	68.3	7.5	203	72.7	37.9
6	On wire 4 weeks—no sunporch	On litter—confined to house	21	57.1§	1299	1348	107.0	51.9	68.8	7.7	211	77.5	31.8
					October 1, 1931 to July 31, 1932 (10 months)								
1	Range grown—purchased	Wire floor—screened sunporch	25	20.0*	1260	1484	80.1	55.8	52.4	7.8	133	62.1	63.9
2	Range grown—purchased	On litter—screened sunporch	25	20.0†	1294	1391	79.3	53.0	51.2	7.7	158	86.3	65.2
3	Range grown—purchased	On litter—double yards	25	28.0	1242	1491	95.2	53.5	46.8	5.9	310	77.9	57.1
4	Range grown—purchased	On litter—double yards	25	24.0	1299	1474	95.2	54.2	48.3	6.1	395	74.7	30.4
5	Range grown—purchased	Wire floor—confined to house	25	36.0‡	1259	1535	74.2	55.3	54.3	8.8	85	48.9	36.5
6	Range grown—purchased	On litter—confined to house	25	40.0	1195	1370	96.1	53.4	57.8	6.0	232	77.1	64.2

* One of five by cannibalism.

† Three of five by cannibalism.

‡ Three of nine by cannibalism.

§ Four of twelve due to cannibalism.

TABLE 5

Results with Mature Birds—1932-1935

Lot No.	Management During Growth	Management as Layers	No. in Lot	Mortality and Culled	Body Weight		Eggs per Bird	Average Egg Weights (in Grams)	Feed Consumption		Hatching Record		Per Cent Hatch of Fertile Eggs
					Average for October 1	Average for Exp. Year			Average per Bird	Per Dozen Eggs Produced	Number Fertile Eggs Set	Per Cent Fertility	
					October 1, 1932 to June 30, 1933 (9 months)								
1	Battery 4 weeks, then wire floor—screened sunporch	Wire floor—screened sunporch	40	32.5*	1238	1417	85.8	54.8	53.3	7.1	212	90.2	48.1
2	Battery 4 weeks, then litter floor	On litter—outdoor cinder court	30	16.7	1363	1528	89.4	53.3	53.0	7.1	249	92.5	55.1
3	Battery 12 weeks, then laying house—double yards	On litter—double yards	26	23.1	1236	1522	127.6	53.6	64.2	6.0	230	96.2	71.3
4	On litter 12 weeks, then rotated growing range	On litter—double yards	21	14.3	1380	1581	122.3	56.5	65.4	6.5	317	97.5	68.1
5	Battery 4 weeks—wire floor to 12 weeks, then growing range	Wire floor—double yards	26	11.5	1296	1539	114.6	54.3	53.4	5.6	212	97.7	66.0
6	Battery throughout	Individual laying cages	38	13.2	1320	1432	117.7	52.3	68.2	7.0	244	81.3	38.5
Group					October 1, 1933 to July 31, 1934 (10 months)								
I	Battery grown pullets from battery kept dams	Individual laying cages	21	35.0	1330	1419	95.6	49.7	48.4†		56	68.0	82.0
II	Range grown pullets from range kept dams	Individual laying cages	15	20.0	1493	1509	98.6	53.9			68	81.0	74.0
III	Battery grown hens second year of production	Individual laying cages	10	10.0	1322	1447	78.8	52.2			27	42.0	85.0
					October 1, 1934 to May 31, 1935 (8 months)								
I	Battery grown. Two and three-year-old hens	Individual laying cages	23	22.7	1457	1641	82.7	57.3	48.2		7	13.7	71.4
II	Battery grown pullets from battery kept dams	Individual laying cages	22	45.4	1266	1458	109.2	52.2			112	54.1	60.7

* Four of thirteen by cannibalism.

† Skimmilk was fed ad libum in addition to this feed for three months.

was apparent in egg size although eggs in lot 6 averaged 1.2 to 2.6 grams smaller than those of the other lots.

Three of the four confined lots consumed more feed per bird than those with green feed available and all of the confined birds required more feed per dozen eggs produced than did those with outside runs.

Fertility was low in all pens, perhaps due to the males used. Hatchability of fertile eggs was rather low in all pens, but those from the lots with yards hatched notably better than the others.

1931-1932 Test

The test for this year was conducted chiefly with purchased pullets that had been range grown. Mortality was highest in lot 6, confined to the house on litter. It was practically as high in lot 5, confined on wire, but in this lot one-third of the mortality was due to cannibalism. The confined lots with sunporches (1 and 2) had somewhat lower mortality than the lots with yards. Cannibalism accounted for 20 per cent of the mortality in lot 1 and 60 per cent of the mortality in lot 2.

The birds in lot 6 were smaller at the beginning of the year and continued to average smaller through the experimental year. Lot 2 averaged about one-fourth pound lighter than the remaining four lots. The egg production of one confined lot (lot 6) equalled that of the lots running outside, but the other three confined lots averaged about 15 eggs per bird less. Egg weights for the several lots ranged from 53 grams to 55.8 grams, but since the most diverse weights occurred in confined lots, the management of the layers was not considered responsible for the variation.

The four confined lots consumed more feed per bird and per dozen eggs (except in lot 6) than did those with outside green feed available.

Fertility was lowest in the two lots confined on wire floors. This is due perhaps to difficulties in mating on this type of floor. The fact that only one male was mated to 25 females is at least partly responsible for the relatively low fertility in all lots. Hatchability was much lower in one range lot (4) and one confined lot (5) with little difference in the other four lots.

1932-1933 Test

For the 1932-33 test several lots of layers were managed somewhat differently. Lot 2 was given an outdoor cinder court instead of a wire-floored sunporch; lot 5 had a wire-floored house as previously but was given access to rotated yards; lot 6 birds were reared in batteries throughout and were placed in individual laying cages when mature.

Mortality was not high except in lot 1, confined on wire, and in lot 3 (moved to the laying house at 12 weeks of age). In the former case 30 per cent of the mortality was the result of cannibalism. Birds of lots 1 and 3 were smaller at the start of the laying year, while those in lots 1 and 6 averaged somewhat lighter in weight for the year. These two lots were confined more closely than were the others.

Production was appreciably lower (2 to 3½ dozen eggs per bird) in the lots confined on wire floor (lot 1) and on litter (lot 2), but those in the laying cages laid practically as well as the birds with range available. Eggs from the laying battery pullets were of smallest size. They averaged from 1 to 4.2 grams lighter than those from other pullets. Considerable variation in egg weight occurred in the three lots with outdoor runs.

The laying battery lot consumed more feed per bird than the other lots although only slightly more than two of the outdoor lots. The three lots with range consumed less feed per dozen eggs than the three confined lots. Fertility was entirely satisfactory in all lots except lot 6, in which case the birds were stud mated in wire-bottomed coops. Two males were used in this lot, each being mated to 19 pullets. Each female was mated every six days during the breeding season. Hatchability was appreciably higher in the lots ranging outdoors. It was lowest in the laying battery lot.

1933-1934 LAYING BATTERY

Only lot 6, laying battery, was continued after the summer of 1933. The birds in this lot were divided into three groups. Group I contained battery grown pullets from battery dams, group II range grown pullets from range dams and group III was made up of birds held over from the laying battery lot of the previous year, kept in laying batteries for the second year of production. Mortality during the laying year was highest for the battery grown pullets and lowest for the second year battery hens. The range grown pullets were heavier at the beginning of the year and averaged heavier during the year than the battery hens or pullets. Egg production was rather low in all groups, due in part to a somewhat unsatisfactory ration.

Production of the two groups of pullets was about equal with the egg production of the hen group, averaging about twenty eggs less per bird. The eggs of the battery pullets were of very small size. It should be mentioned, however, that these pullets were from small egg dams (see lot 6, 1932-33). Feed consumption data are not available for the separate groups in the work of the last two years. A small sample of fertile eggs was set from each group. Fertility was highest for the range grown pullets and very low for the second year battery hens. The hatchability of fertile eggs was satisfactory in all three groups.

1934-1935 LAYING BATTERY

Two laying battery groups were continued for another laying year. Group I was composed of battery grown hens in the second and third years of production and group II of battery grown pullets from laying battery dams. Again the mortality of the battery grown pullets from laying battery dams was quite high. Mortality for the older hens was also greater than it was for similar birds the year previous. The group I hens were heavier for the current year than those of the older hen group for the preceding year. Egg production was appreciably greater for both groups than for the laying battery birds of previous years. This is attributed chiefly to improvement in the ration. Egg weight was again somewhat low for the pullet group, but was satisfactory for the older group. Very low fertility was obtained from the old hens. That for the pullet group was also quite low although much better than for group I. The eggs that were fertile hatched satisfactorily.

DISCUSSION AND SUMMARY

Under the conditions of the experiment the chicks brooded on litter from the start were handicapped from the standpoint of growth and of mortality. Three years of four the lot suffered a severe outbreak of coccidiosis. Coccidiosis also occurred on two occasions in the lots placed on litter at four weeks. These results indicate that wire-floors or battery brooders are desirable where coccidiosis is prevalent in virulent form, particularly if a large number of chicks are to be brooded together.

In each of the last two years of the experiment two series of chicks were hatched. The results clearly show the advantage of early hatching. In practically every case the earlier hatched chicks grew faster and growth was more uniform. Mortality was usually higher in the later hatched chicks.

Laying house mortality was considerably higher in the confined pens, and particularly in those confined without access to a sunporch. In these confined lots about one-third of the mortality was caused by cannibalism. The confined birds, especially those on wire floors, developed the habit of feather picking in all cases.

Mortality was high in the pullets from dams that were kept in laying batteries, when the pullets also were reared in batteries and kept in a laying battery. It is not generally recommended that breeding birds be kept in laying cages, hence such pullets were from more extremely confined stock than would ordinarily be used commercially. Mortality of birds in the laying battery, aside from the pullets from battery dams, were about the same as comparable lots with outdoor range. It was lower than that of pullets confined to the laying house.

For two years of three, the lots of pullets moved to the laying house at twelve weeks of age were small at the beginning of the laying year. These lots also suffered high mortality before mature. Coccidiosis in the pullets after twelve weeks of age was a factor contributing to this mortality. These results indicate the disadvantages of rearing pullets in houses and yards used by mature birds. Birds confined to the house without a sunporch averaged lightest in weight for the year during the two years such lots were used. Battery grown pullets kept in laying cages were smaller at the beginning of the year and during the year than were range grown pullets kept under like conditions.

Birds with outdoor runs planted to green feed crops produced one to three dozen eggs per bird more than those confined to the house. The laying battery pullets laid as well in some cases as pullets with yards available but their egg records are not directly comparable. They were not only subjected to different environmental conditions because kept during different years (two years of three), but also the rations of the battery birds were changed somewhat during the final two years. No differences in egg weight were directly attributable to management of the layers. The laying battery pullets produced smaller eggs in most cases but since they were from small egg dams the size of eggs cannot be charged to management alone. The confined lots in all cases except one consumed more feed per bird and per dozen eggs than did those with green feed available.

Hatchability was appreciably higher in the lots with yards. Fertility was lower in the lots confined on wire floors and in the stud mated laying battery lots, due probably to difficulties in mating under these conditions.

In the light of the results of these experiments it is recommended that laying birds be given alternated outdoor ranges planted to green feed crops, except in those cases in which it is impractical to supply green feed and to maintain reasonable sanitation due to poor drainage or to type of soil.

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Permanent Pastures for Cattle Production in the Rice Area of Southwestern Louisiana

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. Dowell, *Director*

In Cooperation with

DIVISION OF CEREAL CROPS AND DISEASES
BUREAU OF PLANT INDUSTRY
UNITED STATES DEPARTMENT OF AGRICULTURE

Permanent Pastures for Cattle Production in the Rice Area of Southwestern Louisiana

(PRELIMINARY REPORT)

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INTRODUCTION

Realizing that cattle raising is of considerable importance in the rice growing section of southwestern Louisiana, a permanent-pasture experiment was started at the Rice Experiment Station at Crowley in the fall of 1931.

The general practice in rice farming is to grow a rice crop, then use the land for cattle pasture the following year. By this method the farm is usually divided into two main parts, of which one is sown to rice and the other grazed in alternate years. This method has a twofold purpose, namely, the growing of rice primarily and the raising of beef cattle.

Rice farmers are coming to realize that there is a possibility of making cattle raising, as an adjunct to rice growing, a more profitable enterprise. Unfortunately, cattle have been used mainly by the rice growers, for the purpose of destroying weeds that are detrimental to profitable rice culture. This objective has resulted in the cattle receiving little attention and in the use of low grade cattle that have given the farmer little or no direct profit. During the summer and fall months there usually is sufficient growth on the land to keep cattle in fair condition. This, however, is not true in dry years. The principal crop for summer grazing is volunteer red rice, an objectionable variety that has become the most troublesome weed in rice fields.

In winter and spring there is very little growth of any kind on land on which rice was grown the previous year. Land grazed in the summer is usually plowed in the fall, in preparation for the next rice crop, and this destroys most of the vegetation. It is during the winter and spring months that there is special need for hay or better pastures.

Before improved farm machinery came into general use the levees throughout the rice fields were uncultivated and allowed to become sodded with grass, and often the grass would spread scatteringly into the fields, frequently affording some pasturage during mild winters, and up to the time the rice crop was seeded. The grass that formerly grew abundantly on the levees is *Paspalum urvillei,* Steud., locally known as Bull grass. Now that the levees are kept clean and are cultivated and seeded to rice, there is practically no grass available for cattle during the winter and spring months. This in most cases forces the cattle to subsist entirely upon rice straw. While rice straw is in abundance and has some food value, it alone will not satisfactorily sustain cattle. This is a recognized fact, emphasized by the poor condition of the cattle and the large number that die, especially in severe winters.

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[1] The writer is indebted to the late Dr. A. H. Meyer, and Prof. R. H. Lush of the Louisiana State University, and Prof. W. R. Dodson, formerly in charge of the Iberia Live Stock Station, Jeanerette, La., for their assistance in planning these investigations.

Grasses and other pasture plants do not thrive the first year following a crop of rice. In fact it takes four to five years to establish pasture crops on lands that have been devoted to rice growing over a period of years.

In the four principal rice growing parishes of Acadia, Jefferson Davis, Vermilion, and Calcasieu, the total number of cattle in 1934 according to the 1935 Federal Farm Census preliminary report, was 176,251. This is about 16 per cent of all the cattle in the state of Louisiana. These four parishes, in 1934, according to the same census grew 295,028 acres of rice. This means that there is about one animal to every 1.7 acres of rice. All of the cattle, however, are not raised on land devoted to rice, but a large percentage of them are.

OBJECT OF THIS EXPERIMENT

The object in starting a permanent-pasture experiment was to determine what pasture crops of a permanent nature could be grown on rice lands in southwestern Louisiana that would afford pasturage or hay for cattle to supplement the ordinary native vegetation provided in the general program of cattle raising in connection with rice growing, as well as to secure information relative to the best treatment for such pastures.

METHOD OF EXPERIMENTATION

This experiment was conducted in 14 large single plots of which three were fertilized and limed; five were fertilized only; three received lime only; and three received neither fertilizer nor lime. The fertilizers were applied at the rate of 600 pounds of 16 per cent superphosphate and 200 pounds of muriate of potash per acre, at the time the land was prepared for seeding in January, 1932. No additional fertilizer has been applied. The following spring, lime in the form of ground limestone was applied to those plots receiving lime at the rate of 2,000 pounds per acre in one application.

PASTURE PLANTS USED

The plots were divided into two general groups. Those in which no seed was sown, allowing a natural growth to develop; and those that were seeded to mixtures of grasses and clovers. Four plots were seeded to a mixture of Bermuda grass, White Dutch clover and common lespedeza; four were seeded to a mixture of Bermuda grass, Dallis grass, lespedeza, Persian clover, and White Dutch clover; and the remaining 6 plots were not seeded. All plots were prepared in the same manner but those not seeded were left for a natural growth to develop.

CULTURAL TREATMENT OF THE PLOTS

The plots were not grazed but mowed once each month during the growing season. Mowing some years has begun as early as the latter part of March.

All plots, with the exception of one check plot, are to be disced if they become sod-bound or carpet grass crowds out the other plants, both of which in the course of time are likely to occur. The plots have been seeded 4 years, however, and indications are that several more years may elapse before they will have to be scarified or reseeded. One plot of native grasses is to be scarified as often as necessary and another is to remain undisturbed as a check.

EXPERIMENTAL RESULTS

In 1932 the plots were mowed several times during the growing season. No attempt was made to get yields as the plants had not become well established.

White clover made the best growth. The stands of lespedeza and Bermuda were very good. The stand of Dallis grass was fair and seed of good quality was produced in the late fall. Persian clover made very little growth.

In 1933 the plots were clipped 4 times, once each month beginning April 17. The yields each year were estimated by clipping five 5-foot squares from each plot. A certain weight of green matter was cured and from this the yield per acre in cured hay was estimated. In seeded plots, there was an increase of from one-half to one ton of dry matter per acre in favor of the fertilized plots. In the unseeded plots, however, there was no increase due to fertilization. The effect of lime was easily detected in the early part of the season, especially its stimulating effect on the growth of White clover. For the season, however, the total yield did not show an increase in two of the six plots that received lime.

As the season advanced Crab grass increased in most plots, especially in the areas that had produced heavy crops of White clover. Bermuda grass and lespedeza increased in plots that were not seeded. Dallis grass increased and was the principal crop on plots on which it was sown. Bermuda and common lespedeza mature seed in this section and are usually found growing where conditions are favorable; for these reasons they usually increase for several years when the soil is prepared and left uncultivated.

In 1934 the plots were clipped 4 times, once in June, July, August, and October.

The effect of lime was easily detected by its stimulating effect on the growth of White clover and its possible retarding effect on the growth of lespedeza.

As the season advanced Bermuda grass and lespedeza increased. Clovers, of course, disappeared. Dallis grass continued to spread and produced good pasturage until it was killed back by low temperatures.

The plots having Dallis and Bermuda grasses produced pasturage over a longer period than did any of the other plots. Persian clover had practically disappeared.

In every case the yields of hay were increased by liming, and the fertilized plots produced higher yields of hay than those not fertilized.

In 1935 the plots were clipped 5 times, once in April, June, July, August, and October.

In the first three clippings the beneficial effect of liming was reflected in practically all plots, but in the last two clippings its effect was not so apparent. This difference is probably due to the stimulating effect of lime on clover, the growth of which diminishes as the season advances, and to the possible retarding effect of lime on lespedeza, the growth of which increases as the season advances.

Bermuda, native, and Dallis grasses increased during the season. Clovers were not so vigorous as in past years but were more widely distributed. Lespedeza was scattered generally throughout the plots but its growth was very poor.

There was an increase in yield of hay in favor of fertilizer without lime in all plots save those containing Dallis grass.

There was an increase in yield of hay in favor of lime in all plots save those that were not seeded. This was probably due to the scarcity of White clover in these plots.

TABLE 1

Annual Average and Three-Year Annual Average Yields of Cured Hay Obtained in the Permanent-Pasture Experiment at the Rice Experiment Station, Crowley, Louisiana, for the Years 1933, 1934, and 1935

Plot Number*	Total Dry Weight per Acre in Pounds and Tons												Three-Year Average Dry Weight per Acre			
	1933				1934				1935							
	Not Limed		Limed		Not Limed		Limed		Not Limed		Limed		Not Limed		Limed	
	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons
1-A†	8330	4.17			6917	3.46			5405	2.70			6951	3.48		
2-A	10695	5.35			7778	3.89			6491	3.25			8321	4.16		
1-B			8280	4.14			7569	3.78			7062	3.53			7637	3.82
2-B			11489	5.74			10527	5.26			8555	4.28			10190	5.10
3-A	6391	3.20			5638	2.82			6809	3.40			6279	3.14		
4-A	6255	3.13			7343	3.67			7279	3.64			6959	3.48		
3-B			5279	2.64			6907	3.45			6370	3.19			6185	3.09
4-B			6677	3.34			8167	4.08			6505	3.25			7116	3.56
5-A	7422	3.71			5580	2.79			5800	2.90			6267	3.13		
6-A	8607	4.30			9758	4.38			5610	2.81			7358	3.68		
5-B			8326	4.16			4148	2.07			6399	3.20			6291	3.15
6-B			10353	5.18			10158	5.08			7175	3.59			9229	4.61
Average 1-A to 6-B	7983	3.99	8401	4.20	6852	3.43	7913	3.95	6232	3.12	7011	3.51	7023	3.51	7775	3.89
7	7939	3.97			5798	2.90			4778	2.39			6172	3.09		
8	7298	3.65			5879	2.94			5256	2.63			6144	3.07		
Average 7 and 8	7619	3.81			5339	2.67			5017	2.51			6158	3.08		

* 1. Bermuda grass, White clover, common lespedeza (not fertilized).
2. Bermuda grass, White clover, common lespedeza (fertilized).
3. Native grasses (not fertilized).
4. Native grasses (fertilized).
5. Bermuda grass, Dallis grass, common lespedeza, Persian clover, and White Dutch clover (not fertilized).
6. Bermuda grass, Dallis grass, common lespedeza, Persian clover, and White Dutch clover (fertilized).
7. Native grasses, sod broken as often as necessary (fertilized).
8. Native grasses, sod never broken (fertilized).

† "A" plots not limed; "B" plots limed.

DISCUSSION

The highest 3-year average yield of cured hay in the unfertilized plots was from plot 1-A, containing a mixture of Bermuda grass, White Dutch clover, common lespedeza and some native grasses; plot 3-A, native grasses ranked second; and 5-A containing Dallis grass, White Dutch clover, and lespedeza was third.

While the yield of cured hay was less in plot 5-A, this plot and plot 5-B have afforded the best all-the-year-round pasturage. The pasturage in the other plots has been most abundant in early spring, from the end of March to June, when clovers are at their best.

The highest 3-year average yields of cured hay in the plots receiving both fertilizer and lime was from plot 2-B, with plot 6-B second and 4-B third.

TABLE 2

Annual Average and Three-Year Annual Average Yields of Cured Hay, for Plots Fertilized and Plots Not Fertilized, and Plots Limed and Plots Not Limed, in the Permanent-Pasture Experiment, Rice Experiment Station, Crowley, Louisiana, for the Years 1933, 1934, and 1935

Treatment	Average Yields per Acre in Pounds and Tons							
	1933		1934		1935		Average	
	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons
Fertilized and not limed	8519	4.26	7660	3.83	6460	3.23	7546	3.77
Not fertilized and not limed	7448	3.72	6045	3.02	6005	3.00	6499	3.25
Limed and fertilized	9506	4.75	9617	4.81	7412	3.71	8845	4.42
Limed and not fertilized	7295	3.65	6208	3.10	6610	3.31	6704	3.35
Difference in favor of fertilizer in unlimed plots	1071	.54	1615	.81	455	.23	1047	.52
Difference in favor of fertilizer in limed plots	2211	1.10	3409	1.71	802	.40	2141	1.07
Difference in favor of lime in fertilized plots	987	.49	1957	.98	952	.48	1299	.65
Difference in favor of lime in plots not fertilized	−153	−.07	163	.08	605	.31	205	.10

The 3-year average yields of cured hay were higher in all plots receiving fertilizer and lime than in the controls.

Both fertilizer and lime gave the best results when applied together rather than separately. The indications are that lime applied alone is of little or no value from the standpoint of increasing pasturage. There is evidence that fertilizer costing not more than $36.00 per ton, when applied alone, is profitable.

The indications are that the greatest increase in pasturage or hay may be expected from the application of both fertilizer and lime.

Because of the possible retarding effect of lime on the growth of lespedeza and its stimulating effect on the growth of White Dutch clover, both of which are valuable pasture plants, making their best growth at different seasons of the year, it would seem advisable to supply lime in strips rather than over the entire pasture.

SUMMARY

Cattle raising, as an adjunct to rice growing, is practiced throughout southwestern Louisiana. On most farms cattle have not given profitable returns, because of lack of sufficient pasturage, nutritious hay, and low grade animals.

From results obtained during three years from a permanent-pasture experiment, and from observations, indications are that much may be accomplished in placing the cattle industry of southwestern Louisiana on a profitable basis by giving special attention to improved permanent pastures and to hay making to provide feed for the cattle at a time when there is little or no natural grazing available in the rice area.

It requires three to five years to establish a fairly good pasture on ordinary rice land. Permanent pastures can be established by preparing the soil, using fertilizers, sowing seed of recognized pasture plants, and caring for the pastures by occasional mowings to keep down objectionable weeds.

Some of the best pasture plants for the rice section are Bermuda and Dallis grasses, common lespedeza, White Dutch clover, and California Bur clover. The latter was not used in the pasture plots but has been observed for several years where it was sown on some of the station roadways.

In these experiments the most rapid growth was obtained from a mixture of White Dutch clover, Bermuda grass, and lespedeza. The mixture including Dallis and Bermuda grasses, White Dutch clover and lespedeza has provided pasturage for the longest period in the year. Dallis grass affords some pasturage in mild winters and starts growing in early spring. Bermuda begins growing as soon as the weather gets warm and continues until killed down by frost.

Hay may be made by mowing the permanent pasture in the summer, when there is pasturage for the cattle on the fallow rice lands, or by providing special areas for hay purposes.

In the three years that this pasture experiment has been under way more than enough hay has been made on the three acres occupied than is required by the six work animals on the farm.

On the plots that were not seeded Hop clover, lespedeza, White Dutch clover, Bermuda and other grasses are becoming established.

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Effect of Date of Seeding on the Length of the Growing Period of Rice

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In Cooperation with

DIVISION OF CEREAL CROPS AND DISEASES
BUREAU OF PLANT INDUSTRY
UNITED STATES DEPARTMENT OF AGRICULTURE

Effect of Date of Seeding on the Length of the Growing Period of Rice[1]

By J. Mitchell Jenkins

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Industry, United States Department of Agriculture, and Superintendent
of the Rice Experiment Station, Crowley, Louisiana

INTRODUCTION

After growing a large number of rice varieties for several years at the Rice Experiment Station, Crowley, it became evident that information was needed relative to the effect of the time of seeding on the length of the growing period.

The importance of such information was emphasized when the time came to release to farmers rices that gave evidence of being valuable for commercial purposes. On the station the majority of the rice varieties were sown about the same date each year, and this date averaged somewhat later than that upon which the bulk of the commercial crop was sown.

Farmers had a general idea as to the growing periods of the two or three rice varieties they were growing, when seeded at extremely early or extremely late dates. Many farmers had the impression, however, that harvest time would occur about the same time each year even if there was a difference of as much as several weeks in the time of seeding. This impression, in former years, was due to the fact that seeding was done as soon as the seedbed could be prepared with the then prevailing equipment and this was usually about the same time each year. The same three varieties were grown for many years. Two of these varieties, Carolina Gold and Honduras, have a short growing period and the other, Wataribune, has a medium growing period with the characteristic of shortening its growing period when sown late in the season.

Some rice varieties released by the station have failed to produce normal crops when grown by farmers for the reason that they have long growing periods of practically fixed duration and if seeded too late will not mature fully before frost. Other varieties having a medium growing period when sown in sections of Louisiana in which early seeding is the common practice, in contrast to much later seeding on the station, were ready for harvest some time before this operation was anticipated.

OBJECT OF THIS EXPERIMENT

The necessity for knowing the length of the growing period of rices that were to be released to farmers was realized as far back as 1917, and at that time an experiment was started, first with one variety, primarily for the purpose of determining the best seeding date. Later, another variety was added.[2] In order to get additional information on the growing periods of several varieties a pot experiment was started in 1929.

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[1] Cooperative investigations between the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Louisiana Agricultural Experiment Station.

[2] Some of the results of this experiment were published in U. S. D. A. Department Bulletin No. 1365, and in the Annual Report of the Agricultural Experiment Stations of Louisiana State University, 1926.

TABLE 1

NUMBER OF DAYS FROM EMERGENCE OF PLANTS TO EMERGENCE OF THE FIRST PANICLE, FOR 12 RICE VARIETIES SEEDED ON DIFFERENT DATES, IN POTS, FOR THE YEARS 1929-1933 INCLUSIVE, AND 5-YEAR AVERAGE; AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Variety and Date Seeded	Days from Emergence to First Panicle					
	Years					5-Year Average
	1929	1930	1931	1932	1933	
	Days	Days	Days	Days	Days	Days
Early Prolific						
March 1	83	88	91	94	84	88
March 15	83	90	94	101	89	91
April 1	89	94	83	87	91	89
April 15	86	90	80	86	86	86
May 1	77	80	79	73	83	78
May 15	79	80	76	86	76	79
June 1	74	72	77	72	77	74
June 15	73	70	68	54	72	67
Average	81	83	81	82	82	82
Caloro						
March 1				82	73	78*
March 15				94	74	84
April 1				90	108	99
April 15				96	88	92
May 1				79	83	81
May 15				77	80	79
June 1				74	75	75
June 15				47	65	56
Average				80	81	81
Delitus						
March 1	102	113	102	105	99	104
March 15	99	109	107	103	103	104
April 1	97	101	96	95	101	98
April 15	92	96	92	94	95	94
May 1	86	87	91	84	91	88
May 15	81	87	83	85	89	85
June 1	86	83	83	83	86	84
June 15	83	77	81	65	80	77
Average	91	94	92	89	93	92
Wataribune						
March 1	120	115	99	103	103	108
March 15	116	101	107	113	101	108
April 1	99	97	....	106	108	103
April 15	96	101	97	106	101	100
May 1	88	92	97	90	96	93
May 15	85	87	90	88	88	88
June 1	79	77	77	83	78	79
June 15	70	67	71	54	72	67
Average	94	92	91	93	93	93
Fortuna						
March 1	110	117	118	114	111	114
March 15	106	116	119	111	114	113
April 1	102	111	106	103	112	107
April 15	104	106	111	100	99	104
May 1	97	101	99	100	104	100
May 15	98	93	92	98	99	96
June 1	93	92	93	99	94	94
June 15	88	84	88	84	90	87
Average	100	103	103	101	103	102
Iola						
March 1	132	126	134	126	129	129
March 15	127	122	140	129	125	129
April 1	122	124	129	120	123	124
April 15	117	118	125	115	118	119
May 1	113	107	121	106	112	112
May 15	110	109	108	107	121	111
June 1	101	106	108	106	105	105
June 15	105	104	106	88	100	101
Average	116	115	121	112	117	116
Vintula						
March 1	99	100	99	97	91	97
March 15	94	95	97	102	94	96
April 1	89	97	91	90	92	92
April 15	83	89	87	91	90	88
May 1	74	85	83	76	85	81
May 15	79	80	74	80	77	78
June 1	72	77	77	77	78	76
June 15	73	68	71	56	80	70
Average	83	86	85	84	86	85
Honduras						
March 1	102	94	104	101	....	100
March 15	95	100	102	94	96	97
April 1	91	100	....	88	98	94
April 15	85	96	84	91	95	90
May 1	77	85	83	77	85	81
May 15	81	82	76	82	81	80
June 1	79	77	77	77	81	78
June 15	78	74	74	51	72	70
Average	86	89	86	83	87	86
Shoemed						
March 1				102	101	102*
March 15				110	105	108
April 1				97	98	98
April 15				94	99	97
May 1				86	85	86
May 15				85	84	85
June 1				81	81	81
June 15				65	74	70
Average				90	91	91
Acadia						
March 1	105	96	99			100†
March 15	121	105	105			110
April 1	101	108	105			105
April 15	97	103	99			100
May 1	88	93	97			93
May 15	85	85	90			87
June 1	79	78	80			79
June 15	73	68	71			71
Average	93	92	93			93
Blue Rose						
March 1	132	113	130	131	136	128
March 15	127	125	132	131	127	128
April 1	111	121	129	121	123	121
April 15	106	109	113	119	114	112
May 1	92	96	109	100	106	101
May 15	91	90	92	99	93	93
June 1	83	83	86	91	90	87
June 15	78	77	78	65	83	76
Average	103	102	108	107	109	106
Rexoro						
March 1	129	133	148	138	133	136
March 15	139	133	140	138	138	138
April 1	130	140	138	130	133	134
April 15	128	129	148	124	126	131
May 1	112	120	121	112	122	117
May 15	114	115	111	115	117	114
June 1	103	111	112	113	105	109
June 15	103	104	104	100	106	103
Average	120	123	128	121	123	123

* Two year average.
† Three year average.

METHOD OF EXPERIMENTATION

The varieties were sown in soil in galvanized iron cans 15 inches square. Twelve varieties were seeded every two weeks beginning March 1 and ending June 15 during a period of five years. Records were kept of the date of germination; percentage of stand, based on 100 seeds planted in each can; date of application of irrigation water; and date of emergence of the first panicle.

This paper deals especially with the length of the growing period from the emergence of the plants to the emergence of the first panicle of 12 varieties seeded on different dates. No attempt was made to obtain yields.

RICE VARIETIES USED

The varieties used included old and new commercial rices, varieties recently released by the station, and rices giving promise of becoming of value for commercial purposes. The first group included Honduras and Wataribune; the second group, Blue Rose, Early Prolific and Caloro; the third group, Fortuna and Delitus; and the fourth group, Vintula, Rexoro, Acadia, Iola and Shoemed. Caloro and Shoemed were grown only in 1932 and 1933. Acadia was grown only in 1929, 1930, and 1931. The rices used included varieties of short, medium and long growing periods; and of long, medium and short grain types.

TABLE 2

Average Number of Days from Emergence of Plants to Emergence of the First Panicle for 12 Rice Varieties, Seeded on Different Dates, in Pots, for the Five Years 1929 to 1933 Inclusive. Difference in Days and in Percent Between Longest and Shortest Growing Period. Rice Experiment Station, Crowley, Louisiana

Dates Seeded	Varieties Arranged According to Length of Growing Period											
	Early Prolific	Vintula	Caloro†	Honduras	Delitus	Shoemed†	Wataribune	Acadia*	Fortuna	Blue Rose	Iola	Rexoro
	Days	Days	Days	Days	Days	Days	Days	Days	Days	Days	Days	Days
March 1	88	*97*	78	*100*	*104*	102	*108*	100	*114*	*128*	*129*	136
March 15	*91*‡	96	84	97	*104*	*108*	*108*	*110*	113	*128*	*129*	*138*
April 1	89	92	*99*	94	98	98	103	105	107	121	124	134
April 15	86	88	92	90	94	97	100	100	104	112	119	131
May 1	78	81	81	81	88	86	93	93	100	101	112	117
May 15	79	78	79	80	85	85	88	87	96	93	111	114
June 1	74	76	75	78	84	81	79	79	94	87	105	109
June 15	67	70	56	70	77	70	67	71	87	76	101	103
Average	82	85	81	86	92	91	93	93	102	106	116	123
Difference between longest and shortest growing period,												
In days	24	27	43	30	27	38	41	39	27	52	28	35
In percent	26	28	43	30	26	35	38	35	24	41	22	25

* Three year average.
† Two year average.
‡ Longest growing period italicized for each variety.

EXPERIMENTAL RESULTS

The results are recorded in tables 1 and 2. The varieties are arranged in the tables, according to the maximum length of the growing period. In comparing the growing periods of the twelve varieties for the five years, when sown on different dates, it is found that there is about the same variation from year to year in all varieties and that the variations are about the same for the various dates of seeding.

The longest average growing period for most of the varieties was for the March 1 seeding, however, for Early Prolific, Acadia and Rexoro it was for the March 15 seeding, and for Caloro the April 1 seeding. The longest average growing periods for Delitus, Wataribune, Blue Rose, and Iola were the same for the March 1 and the March 15 seedings.

It is interesting to note that the average growing periods of Caloro were as short or shorter for the March seedings than they were for the May seedings. This indicates that seasonal conditions in the spring had more effect on Caloro than on any of the other varieties.

The average growing period for all varieties decreased, after reaching the maximum, as the seasonal dates of seeding advanced. There was, however, a decided difference in the number of days of decrease in the growing periods of the several varieties. The varieties having the longest range in the average number of days between the maximum and minimum growing periods were Blue Rose, Caloro, Wataribune, Acadia and Shoemed, respectively, and those having the shortest range were Early Prolific, Vintula, Delitus, Fortuna, Iola, Honduras, and Rexoro, respectively.

The largest average percentage of decrease, below the maximum in the growing periods, when seeded on June 15, was 43 for Caloro, 41 for Blue Rose, 38 for Wataribune, 35 for Acadia and Shoemed, and 30 for Honduras; and the smallest average decrease was 22 for Iola, 24 for Fortuna, 25 for Rexoro, 26 for Early Prolific and Delitus, and 28 for Vintula.

DISCUSSION

In rice the maximum average length of time from emergence of the first panicle to full maturity is about 45 days. From the information contained in Table 3, a very accurate estimate can be made as to the time of full maturity of the twelve varieties discussed in this article, when seeded on different dates, with the exception of Caloro, the behavior of which is in some respects different from that of the other varieties.

The earliest date on which ice formed, in the 26 years that weather records have been kept at the Rice Experiment Station, was October 20. Ice seldom occurs before the middle of November.

With information regarding the length of the growing period, and a knowledge of the approximate date the first ice forms in his community, a farmer can determine very closely the time of maturity of a variety when seeded on a given date.

Rices having growing periods of approximately fixed lengths are desirable, if the growing periods are not too long, for one who wants to grow the same variety on a large acreage, or sow on different dates. Rices of this type will mature in the same order in which they are seeded, thus avoiding having the entire acreage mature at one time.

Rices that materially shorten their growing periods are not so desirable for one who wants to grow the same variety on a large acreage, because, with this type of rice, the entire acreage will, regardless of the date sown, mature about the same time. Rices of this type are, however, very desirable for one who is forced to plant his crop late in the spring, for these rices, if not seeded too late, will sufficiently shorten their growing periods to produce a crop before frost.

TABLE 3

Approximate Date 12 Rice Varieties Mature When Seeded on Certain Dates. Determined by Adding 45, the Average Maximum Number of Days from First Panicle Emergence to Maturity, to the 5-Year Average Number of Days from Emergence of the Plants to Emergence of the First Panicle, Rice Experiment Station, Crowley, Louisiana

Dates Seeded	Varieties Arranged According to Length of Growing Period											
	Early Prolific	Vintula	Caloro	Honduras	Delitus	Shoemed	Watari-bune	Acadia	Fortuna	Blue Rose	Iola	Rexoro
March 1	July 12	July 21	July 2	July 24	July 28	July 26	Aug. 1	July 24	Aug. 7	Aug. 21	Aug. 22	Aug. 29
March 15	July 29	Aug. 3	July 22	Aug. 4	Aug. 11	Aug. 15	Aug. 15	Aug. 17	Aug. 20	Sept. 4	Sept. 5	Sept. 14
April 1	Aug. 13	Aug. 16	Aug. 23	Aug. 18	Aug. 22	Aug. 22	Aug. 27	Aug. 29	Aug. 31	Sept. 14	Sept. 17	Sept. 27
April 15	Aug. 24	Aug. 26	Aug. 30	Aug. 28	Sept. 1	Sept. 4	Sept. 7	Sept. 7	Sept. 11	Sept. 19	Sept. 26	Oct. 8
May 1	Sept. 1	Sept. 4	Sept. 4	Sept. 4	Sept. 11	Sept. 9	Sept. 16	Sept. 16	Sept. 23	Sept. 24	Oct. 5	Oct. 10
May 15	Sept. 16	Sept. 15	Sept. 16	Sept. 17	Sept. 22	Sept. 22	Sept. 25	Sept. 24	Oct. 3	Sept. 30	Oct. 18	Oct. 21
June 1	Oct. 1	Oct. 3	Oct. 2	Oct. 5	Oct. 11	Oct. 8	Oct. 6	Oct. 6	Oct. 21	Oct. 14	Nov. 1	Nov. 5
June 15	Oct. 5	Oct. 8	Sept. 24	Oct. 8	Oct. 15	Oct. 8	Oct. 5	Oct. 9	Oct. 25	Oct. 14	Nov. 8	Nov. 10

SUMMARY

Twelve rice varieties were grown over a period of five years to determine the number of days from emergence of the plants to emergence of the first panicle, when seeded at intervals of two weeks, on eight dates beginning March 1 and ending June 15.

The length of the growing period of each variety shortened, after reaching the maximum, as the seasonal dates of seeding advanced. There was, however, a decided difference in the percentages of shortening. Some varieties tend to have a comparatively fixed growing period, while in others it appears that heading will not take place until a certain time in the fall after which their growing periods shorten very materially.

Varieties tending to have a relatively fixed length of growing period include Iola, Fortuna, Rexoro, Early Prolific, Delitus, and Vintula. Varieties that have a tendency not to head until a certain time in the fall and thereby greatly lengthen or shorten their growing periods include Caloro, Blue Rose, Wataribune, Acadia, Shoemed, and Honduras.

By knowing the length of the growing period, when seeded on different dates, any farmer growing a variety for the first time, can approximate very closely the time it will be fully mature if seeded on a given date. If he knows the approximate date when the first ice forms in the fall, he can also determine the latest safe seeding date for his locality.

Rices having growing periods of approximately fixed lengths are desirable for one who wants to grow the same variety on a large acreage.

Rices that materially shorten their growing periods are not desirable for one who wants to grow the same variety on a large acreage. They are very desirable, however, for one who is forced to sow his crop late in the spring.

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Cottonseed Meal Ration and Silage Versus Herd Ration, Hay, and Silage

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C. T. Dowell, *Director*

Cottonseed Meal Ration and Silage Versus Herd Ration, Hay, and Silage

By R. H. Lush

The feeding value of cottonseed meal has been the subject of much study by this and other experiment stations. Agricultural literature formerly contained many warnings against the liberal feeding of cottonseed meal. The results obtained to date indicate that so far as cattle, at least, are concerned, it is a safe and valuable protein feed. However, it is deficient in vitamin A content and is often fed in rations lacking vitamin A and calcium. Unsatisfactory results sometimes obtained in dry lot or winter feeding are due to these deficiencies of the ration, rather than to a harmful substance in the cottonseed meal itself. The work reported here was concerned with correcting those deficiencies by feeding cottonseed meal supplemented with yellow corn or hominy and pasture, silage, and oyster shell flour, in comparison with other feeds. This experimental cottonseed meal ration, or "all Louisiana ration," is also very practical as all of its components can be produced in the state at a lower cost than many dairy feeds. Experimental work was divided into two parts: (1) complete lactation comparisons and (2) winter reversal trials for shorter periods. All feeding trials were carried out in the Louisiana State university dairy herd, with supervision, extra labor, and feed furnished by the experiment station.

I. Comparison of Cottonseed Meal and Soybean Oil Meal

Two groups of six purebred Holstein heifer calves each were started on this phase in November, 1929. Group I received an experimental ration composed of 25 parts soybean oil meal, 75 parts yellow corn, 2 parts oyster shell flour, one part common salt, and corn and soybean silage in winter. Group II received the same ration except that cottonseed meal replaced the soybean oil meal. All other conditions were kept as nearly alike as possible. The heifers were fed according to weight by the Morrison standard except in summer, when silage was replaced by pasture and an average of four pounds of grain was fed daily. Thus all heifers averaged over a pound daily of either cottonseed meal or soybean oil meal, from ten months of age, when they were placed on experiment, until date of freshening. Alluvial land pasture of white clover and Italian rye grass in early spring, replaced by Dallis, Bermuda and Carpet grasses in summer, was available. This was limited somewhat by the dry summer of 1930. From caged areas clipped monthly, a total of 39,566 pounds of grass per acre, equivalent to 9,937 pounds of dried hay, was harvested in the season of 1930. The same areas clipped monthly in 1931 averaged 49,979 pounds of grass per acre, equivalent to 12,763 pounds dried hay, for the season. However, because of uneven distribution of grazing and the presence of other cattle in the pastures, it is difficult to estimate how much these heifers consumed, or that they always had sufficient grass to eat. No dried hay or bedding was consumed until two lactations had been completed.

At the end of the first year there was an average greater gain of only six pounds per heifer for the group fed the soybean oil meal ration than for those fed the cottonseed meal ration, although the general appearance of hair and condition was slightly in favor of the former. Growth was fairly satisfactory, averaging a pound per day for both groups. An attempt was made to breed all heifers to calve in the early fall of 1931, at an age of 30 to 34 months, but three of the heifers on the soybean oil meal ration aborted four- to six-month fetuses in the early spring months. Blood tests made later indicated that two of these were positive to Bang's disease. As that disease was present in the herd, it, rather than the ration, was probably the cause of the abortions. The other nine heifers calved normally, despite the fact that heavy grain feeding was continued to within a few days, or the day, of calving. Two heifers receiving cottonseed meal had slightly caked udders, but the average condition was similar to other heifers on a more varied herd ration. The average period of gestation for the three heifers fed the soybean oil meal ration was 277 days, with an average calf weight of 83 pounds. These heifers averaged 1157 pounds in weight and 125.5 centimeters height at shoulders, or a respective gain of 748 pounds and 22.9 centimeters over weight and measurements at the beginning of the experiment. The heifers which were fed cottonseed meal averaged 272 days gestation, a calf weight of 74 pounds, a weight before calving of 1138 pounds, and 127.6 centimeters in height. The respective gains were 738 pounds and 23.4 centimeters over initial weight and measurements. These figures indicate little difference between the groups up to calving time, although the attendants believed the soybean oil meal heifers to show slightly smoother hair and condition. The cost of feeding, however, was $7.12 greater per heifer in group I for the 21 months prior to calving, due to the high cost of the soybean oil meal.

After freshening, the respective grain rations were gradually increased at the rate of one pound grain to each three pounds of milk produced. Milk production reached 40 pounds daily in all cases, and nearly 60 pounds daily with five heifers. Thus consumption of grain was 18 pounds daily in some cases, with an average of over 16 pounds daily for the first six months of lactation. As one-fourth of the grain mixture was either cottonseed meal or soybean oil meal, the heifers consumed four pounds daily of these high protein feeds for six to ten months with no ill effects, except in one case. A heifer receiving 18 pounds of the soybean oil meal per day developed an inflamed vulva at one period of estrum. A local veterinarian pronounced it typical protein poisoning, but a marked feed reduction overcame the condition in a few days. No other feed irregularities occurred and the heifers readily ate their large rations of concentrated feeds without digestive disturbances. Silage was fed at the rate of six pounds per 100 pounds live weight during the winter, but it was impossible to maintain that consumption on warm, humid days of fall and early spring. Sixty pounds daily were consumed by the larger heifers in cool weather. Heifers were milked and fed three times daily with the regular herd.

All heifers were re-bred to freshen within twelve to thirteen months, with the exception of one, which became a non-breeder because of difficult calving. This heifer, receiving cottonseed meal ration, was eliminated from the experiment. Normal heifers had a gestation period of 279 days on the soybean oil meal ration and 282 days on the cottonseed meal ration. At the end of ten months' lactation, the remaining heifers were dried off and the ones in group I given the cottonseed meal ration, while the others in group II were given the soybean oil meal ration. About four pounds daily were fed for forty days prior to calving, and after freshening the same rate of feeding was followed with the reversed rations as in the first lactation. Silage consumption was greater during this lactation, reaching 70 pounds daily for the larger heifers. No feeding diiffculties were encountered and production was again very high on these rations. At the end of ten months' lactation, these heifers were dried off and the remaining five normal heifers carried through a third lactation on a herd ration, hay, and limited silage as explained later. One of the original eight experimental heifers developed a foot infection and was sold, while one on each of the two rations was not bred in time to calve with the other five heifers. These three are eliminated for third lactations. Results are given in Table 1 for the different lactations. There was very little difference in the average production for the soybean oil meal ration over cottonseed meal in the first lactation. The difference was slightly more in the second test, with an average of 11,022.7 pounds of four per cent fat corrected milk for both lactations on soybean oil meal, which was only 125.7 pounds more than on the cottonseed meal ration. This difference is hardly significant and of no economic importance. At the feed prices current in 1931-1933, and with milk at $1.60 per hundred weight, the returns per cow per year were $19.04 more on the cottonseed meal ration than on the soybean oil meal ration. Moreover, the heifers gained an average of 43 pounds per lactation in live weight while consuming the cottonseed meal ration and only nine pounds on the soybean oil meal ration. This phase of the experiment demonstrated that there is little difference between cottonseed meal and soybean oil meal for growh or milk production, that bulky feeds are not necessary in the grain mixture, and that satisfactory milk production can be maintained without hay when this type of ration is fed.

TABLE 1

AVERAGE POUNDS OF FOUR PER CENT FAT CORRECTED MILK IN 305 DAY LACTATIONS

Ration Fed	First	Second	Average First and Second	Third Herd Ration and Hay	Difference Between Third and Average of First and Second
Soybean oil meal, no hay	10,855.1	11,190.3	11,022.7		
Cottonseed meal, no hay	10,750.2	11,043.9	10,897.0		
Average both rations for heifers with 3 lactations	10,738.8	11,730.4	11,234.6	8,996.8	−2,237.8
Herd ration plus hay	8,686.2	9,352.6	9,019.4	8,612.7	− 406.7
Difference in favor of experimental rations	2,052.6	2,377.8	2,215.2	384.1	1,831.1
Net difference (less 384.1)	1,666.3	1,993.7	1,831.1		
Per cent net increase over herd ration and hay	19.18	21.32	20.30	4.46	

COMPARISON OF EXPERIMENTAL RATIONS AND HERD RATION PLUS HAY BY LACTATIONS

Production on the experimental soybean oil meal or cottonseed meal rations was so much better than for other first-calf heifers in the regular herd that a check group has been included in Table 1. This group is designated as "herd ration plus hay" and consists of three Holstein heifers of slightly older age, which were fed a ration of 40 parts corn or hominy, 20 parts each of oats, wheat bran, and cottonseed meal, and one part salt throughout three normal lactations which covered the same period of time as the experimental groups. This herd ration was fed at the same rate per pound of milk as to the experimental heifers. Mixed legume and grass hay and silage were supplied according to appetite. These heifers were fed less grain prior to calving, but were of approximately the same size as the experimental heifers. They were handled in the same manner and pastured with the experimental group, the only apparent difference being in type of grain mixture fed and the replacement of one-half the silage by hay in winter. The third lactation of the experimental heifers was made under these conditions, as was mentioned earlier. Referring to Table 1, the results can be noted more clearly. During the first lactations, the five heifers on the experimental rations averaged 10,738.8 pounds of fat corrected milk, or 2,052.6 pounds more than the "herd ration plus hay" heifers. In the second lactations, the difference was even greater, the average for both lactations being 2,215.2 pounds in favor of the experimental rations. But in the third lactations of all heifers on the same herd ration and roughage conditions, the experimental heifers produced 2,237.8 pounds less than the average of the two lactations on experimental rations. They produced 384.1 pounds more milk than the check group on the same ration. Therefore, this latter difference may be termed hereditary and is deducted to leave a net difference of 1,831.1 pounds milk, or 20.3 per cent more for the experimental rations than for "herd ration plus hay." The decline for the third lactations of all heifers, when normally an increase would be expected with increased maturity, is probably due to the poorer feed and pasture conditions of 1934, which was a dry year. Grass yields in 1934 were 35,967 pounds per acre, as compared to 41,143 pounds in 1933 and 39,660 pounds in 1932, when the first and second lactations were completed. Adequate grazing was not always available, as more than one animal per acre was maintained on pasture each season.

Applying current feed prices and a milk price of $1.60 per hundred weight for milk produced, one finds the net return per cow per lactation over feed cost for the experimental cottonseed meal ration to be $18.21 greater than with the herd ration and the use of hay. The average analysis of feeds used shows the experimental cottonseed ration to have 6.4 per cent more total digestible nutrients per hundred pounds than the herd ration, which contained bran and oats, more fibrous and less digestible feeds than cottonseed meal and corn. This would explain part of the differences obtained, as the grain was fed at the same rate. The protein content of each ration was approximately the same, being 17 per cent. Since the heifers were on pasture much of the time, there was little danger of a shortage or of poor quality of protein. A likely explanation of the differences is that the increased calcium content of the experimental ration had some effect and that the heifers on the more concentrated grain had greater capacity to eat large amounts of grass outside. The numbers of animals used were so limited that it was decided to repeat this phase with shorter reversal trials in winter, when feed consumption could be measured more accurately.

II. COMPARISON OF EXPERIMENTAL COTTONSEED MEAL RATION AND HERD RATION PLUS HAY BY REVERSAL PERIODS

In the fall of 1932, two groups of five Holstein cows each were started on each ration. Besides the difference in the grain fed to the two groups, mature dehydrated soybean hay was fed at the rate of one pound, and silage at three pounds daily per hundred pounds live weight with the herd ration, while silage alone at the rate of six pounds per hundred pounds live weight was fed with the experimental cottonseed meal ration. The rations were made up in the same proportions as in the earlier work, and corn and soybean silage was used throughout all trials. Cows were milked and fed three times daily, all milk and feed being weighed and recorded. Grain was fed in proportion to milk yield and test, adjusted twice monthly. All experimental cows ran in the same paddock and were otherwise handled alike. At the end of 71 days the rations and roughage were reversed for the two groups, and feeding continued for an additional 71 days. The first ten days of each period were considered preliminary for feed adjustment, and were not included in the results. The soybean hay, dehydrated at a high temperature, was not very palatable, and after the first few days one pound of molasses diluted with water was poured over each feed for both groups to obtain complete consumption.

The results for the two 61 day periods showed 504.3 pounds more four per cent fat corrected milk, or an increase of 2.36 per cent, for the experimental cottonseed meal ration than for the herd ration plus hay. There was also 84 pounds less loss in weight. This trial indicated, if no difference existed between the grain rations, that 281 pounds corn and soybean silage were equal to 100 pounds dehydrated soybean hay.

The second trial was conducted in a similar manner, starting in the fall of 1933. Western alfalfa hay of good quality was substituted for the dehydrated soybean hay. No molasses was fed. Net experimental periods of 80 days each were maintained and the results showed 1275 pounds more four per cent fat-corrected milk, or an increase of 8.22 per cent, for the herd ration and alfalfa hay over the experimental cottonseed meal ration. The cows lost weight on both rations, but lost a total of 105 pounds more while receiving the experimental cottonseed meal ration. With allowance for slightly more grain consumed in the periods when silage was fed alone, it would require 386 pounds corn and soybean silage to equal 100 pounds alfalfa hay. The feed replacement value of the alfalfa hay amounted to $16.20 per ton when silage is valued at $4.00 per ton.

The third trial was like the second except that locally grown, dehydrated alfalfa hay was used, and only four cows were used in each group for a 62-day net period. The four per cent fat-corrected milk yield was 275 pounds, or 1.66 per cent, greater for the herd ration plus alfalfa hay than for the experimental cottonseed meal ration. The four cows lost a total of 254 pounds in weight during the periods, but gained 20 pounds while on the experimental cottonseed meal ration. The feed replacement value of the hay amounts to $14.28 per ton, with silage at $4.00 per ton, if no difference exists in the grain rations. With allowance for difference in feed consumption, but disregarding live weight changes, it required 324 pounds of the silage to replace 100 pounds of alfalfa hay.

The average of the three tests indicates that 330 pounds of corn and soybean silage are required to equal 100 pounds of the legume hays used, disregarding live weight changes and grain difference. The average milk production per cow per day was 28.89 pounds on the experimental ration and 29.44 pounds on the herd ration and legume hay, or an increase of 1.9 per cent for the latter method of feeding. However, because of the high cost of legume hay, oats, and wheat bran, the feed cost of producing milk was less every year on the experimental cottonseed meal ration and silage, averaging ten cents cheaper per 100 pounds when the herd ration and legume hay and silage was fed.

Discussion

This work has not been conclusive because of variations in feeds and conditions from year to year. However, since completing this work, twenty heifers have been successfully fed the experimental cottonseed meal ration for periods of a year or longer. Recent work of the Texas, Oklahoma, and especially the Michigan experiment stations have shown that heavy feeding of cottonseed meal or similar feeds is not injurious to cattle. The grain ration is so thoroughly mixed with water in the paunch as to delay the impaction once thought due to heavy rations. Work of the Florida and Minnesota stations on the importance of calcium, as well as our own observations, point toward oyster shell flour, affording calcium in an otherwise deficient ration, as a very important factor in maintaining production in both experiments. The difference between the lactation methods and reversal trial results may be partly explained by the larger opportunity to obtain and store vitamin A on the experimental cottonseed meal ration in the first experiment. It was noticeable that spring and summer production held up better on that ration than on the herd ration. During the shorter reversal trials the legume hay probably furnished more vitamin A than in the case of the experimental ration, though no actual determinations were made.

This work has demonstrated at least that dairy farmers do not need to include bulky grains, such as oats or wheat bran, in the grain ration when silage or pasture is available. Neither is it necessary to have a great variety of feeds in the ration when pasture and silage are available. The latter roughage and silage apparently can replace all but the best quality hay if calcium and protein are added to the grain ration. If the dairy farmer can produce and feed three and one-half tons of silage for less than the cost of growing, curing, and feeding one ton of legume hay, it is an economical procedure to do so. This "all-Louisiana dairy ration" can be raised or economically purchased in South Louisiana. Where good quality legume hay can be easily cured, as in much of North Louisiana, more of it should be raised and fed. There is little need of a protein supplement other than cottonseed meal when sufficient silage and pasture are supplied to average dairy cows.

SUMMARY

The above tests have demonstrated that under our conditions as outlined, legume hay and a bulky grain ration are not necessary for economical production when silage or pasture, corn, cottonseed meal, and adequate mineral matter are fed. There was no apparent difference between soybean oil meal and cottonseed meal for growth or milk production, fed under the above conditions. The average of these two rations produced approximately 20 per cent more milk per lactation than a herd ration of corn, oats, wheat bran, cottonseed meal, mixed hays, and silage.

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GRAZING AND PARASITICAL STUDIES WITH CATTLE AND SHEEP

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GRAZING AND PARASITICAL STUDIES WITH CATTLE AND SHEEP

By M. G. SNELL

Observations at the Louisiana Agricultural Experiment Station have shown a marked difference in the flora of pastures grazed by cattle and those grazed by sheep. In the cattle pastures, paspalum, white Dutch clover, and Bermuda were the chief forage plants. "Jimson" weeds were more or less in profusion. Just across the fence, the clovers were eaten to the ground, but sedge grass was growing in more or less abundance. This suggested the possibility of beneficial results from grazing cattle and sheep together. This procedure is looked upon with disfavor by the cattlemen, because, they say, the calves become infested with stomach worms from grazing on sheep pasture. Yet, in some areas of the state, cattle and sheep are grazed together with no apparent detrimental results. Consequently, in order to shed some light on the question of grazing and parasitic infection, a grazing experiment was begun, the objects of which were to determine:

1. The acre gains of pastures grazed by (a) cattle exclusively, (b) sheep exclusively, and (c) cattle and sheep together.
2. The effect on pasture herbage of grazing with (a) cattle, (b) sheep, and (c) cattle and sheep together.
3. The effect on pasture gains of improving native pasture by discing and sowing with Italian rye grass and clovers.
4. The parasitic infestation of calves and lambs grown under the three systems of management, namely: (a), (b), and (c).

REVIEW OF LITERATURE

Manow (1888) and Cotton (1906) were among the first to recognize the importance of grazing and the detrimental effects of over-grazing in beef cattle production. Ferris (1917), Snell (1924), and Simpson and Chase (1927) recognize the importance of grazing systems in developing pastures for livestock production. Sampson (1913) reported that deferred and rotated grazing produced the best results. Jardine (1915) used protected and unprotected plots to show the effect of over-grazing on forage growth. Jardine (1919) found that on National Forests horses and cattle made better use of grass ranges than sheep, while sheep made better use of browse, tender grass, and weeds. Cattle consumed coarse grasses and weeds. On ranges where a variety of plants grew, grazing with cattle, if not overdone, was beneficial to sheep. On ranges where weeds were numerous, grazing with sheep aided in maintaining the cattle range. Over-grazing by either cattle, sheep, or both was injurious.

Jayne (1921) found that the farmers of the Northwest favor running cattle and sheep together. Youngblood and Cox (1922) found that the ranges of the Edwards Plateau of Texas were best utilized by grazing with cattle, sheep, and goats. Walker and Lantow (1927) showed that cattle and sheep could be grazed together economically. Parr, Collier, and Klemmedson (1928) made a similar report. Bush (1930) of the Texas Station states: ". . . while sheep and cattle graze mostly on the same plants, sheep may utilize many weeds that cattle leave untouched, while cattle can better utilize the coarser and more mature grasses . . . It has been found . . . that in the diversified grazing so highly developed on the Edwards Plateau, 20 cows, 150 ewes, and 75 goats per section (640 acres) give efficient use of the range."

Semple et al (1934) state: ". . . it is generally best to turn several kinds of livestock on a pasture and to give them only as large an area as they need." Dodd (1935) reports that for a 25-year period the average gain of pastures grazed by sheep was 103.5 pounds to the acre, while lands grazed by cattle and sheep produced 210.5 pounds of gain to the acre. Black (1921) reported a grazing season of approximately seven months for the Corn Belt.

Stevenson, Forman, and Brown (1924) reported that discing produced 1.39 tons of forage to the acre, while discing and reseeding produced 2.26 tons to the acre. Hansen (1929) found that grubbing and burning of pasture lands in Colorado improved grazing. Templeton (1929) reports that cleaning and reseeding of Mississippi pasture lands resulted in long time improvement of pastures. Archibald (1929) found fertilization and rainfall to be very important in pasture production. Bailey (1930) of Canada and Schuster (1931) of the Delaware station reported on the beneficial effects of pasture fertilization.

Internal parasites, particularly stomach worms, have played havoc with the sheep industry in various states. Various stations, including the United States Department of Agriculture, have reported the destructive effect of this parasite, and many have recommended drenching with bluestone as a control measure. (See Bibliography, references 35, 37, 41, 42, 45, 47, 49, 50, 52, 53, 54, 55, 56, 57, 58, 59, and 60). Dalrymple (1905) and Bell (1922, 1923) found that lambs could be raised in a barn or on a bare lot and suffer very little from parasitic infestation. However, these systems do not seem to be practical for commercial production. Bell and Warwick (1928) found that the feeding of tobacco, either in the feed or mixed with salt, was ineffective in controlling stomach worms. Nicotine sulphate was also ineffective when fed in the salt. Boughton and Hardy (1934) found that salt containing bluestone (copper sulphate) produced chronic copper poisoning after from five to twelve months.

Green (1935) states that sheep cannot be concentrated on improved pastures on account of the sheep becoming infested with internal parasites. Dikmans (1923) examined the stomachs of two hundred head of cattle slaughtered at the Baton Rouge, Louisiana, City abattoir. From this examination he estimated that from 75 to 80 per cent of all the calves slaughtered at this abattoir harbor stomach worms. Eighty per cent of the calves killed were infested with hookworms.

PASTURE GAINS OF CATTLE AND SHEEP

Discing and Seeding

The bottom lands adjacent to the lower Mississippi river, sometimes called "Delta" or "riverfront," are composed of rich alluvial soils capable of producing excellent pastures if properly cared for. Bermuda, Dallis grass, Vasey grass, carpet grass, white Dutch clover, black medic, and other grazing crops grow wild and make a luxuriant growth. Italian rye grass, Persian clover, red top, and other grazing or forage plants make good growth when planted.

The first attempt of the Louisiana Agricultural Experiment station to get data on the productive capacity of riverfront lands was made in 1931 on a field of 26.5 acres (Bray, 1933). This piece of land had been planted in corn and soybeans in 1928, followed by winter oats. In February, 1929, white Dutch clover was seeded on the oats. In 1931 this land had a very heavy stand of clover and Bermuda. From March 23 to October 13 this pasture carried 38 head of cattle, mostly yearling heifers, and produced a total gain of 9,900 pounds, or 372 pounds per acre. The average daily gain for this group of cattle was 1.5 pounds per animal up to August 3. After this date and with fewer cattle on the pasture, the average daily gain was 0.83 pounds per animal.

In the fall of 1930-31, Bray (1933) fenced and drained a 22.8 acre black land pasture. This pasture had been in cultivation but had grown up with sedges and water grass with only a small amount of white Dutch clover and Bermuda. During the grazing season of 1931 this pasture carried an average of 13.3 cattle and made a gain of 69 pounds per acre. In the fall of this year (1931) the pasture was divided into two equal lots of 11.4 acres each for experimental purposes. Both lots were mowed. Lot I received no further treatment, but lot II was disced and seeded with 6 pounds of white Dutch clover, 9 pounds of red top, and 9 pounds of Italian rye grass per acre. A small amount of Bermuda grass seed was scattered in areas where no Bermuda was growing. Records of the number of cattle grazed, the beef produced per acre and the average daily gains for the years 1932 and 1933, together with the record of 1931, are shown in table I.

TABLE I. Discing and Seeding Improves Pastures.
(1931-1932)

	Lots I and II, undivided	Lot I Mowed	Lot II Disced, Seeded & Mowed
Number of acres	22.8	11.4	11.4
Average number of cattle			
1931—April 17 to Sept. 12	13.2	----	----
1932—March 19 to Sept. 29	----	9.75	13.5
1933—March 30 to————	----	14.0 Oct. 25	11.7 Oct. 6
Beef produced per acre:			
1931	69.4	----	----
1932	----	174.2	231.6
1933	----	148.6	264.8
Average daily gains:			
1931	.80	----	----
1932	----	1.05	1.00
1933	----	.75	1.03

This table shows that mowing, discing, and seeding produces a marked effect upon the productive capacity of these pastures. The productive capacity in 1931 was very low, being only 69.4 pounds per acre. In 1932, the unimproved portion (lot I) of this pasture produced 174.2 pounds of beef per acre, while the improved half (lot II) produced 231.6 pounds per acre. In 1933, lot I produced 148.6 pounds of beef per acre, and lot II, 264.8 pounds of beef, showing quite conclusively that discing and seeding results in marked increases in gain.

PASTURE IMPROVEMENT FOR CATTLE AND SHEEP

In 1933 a similar experiment was started with sheep. An unimproved pasture, lot IV, was grazed with ewes and lambs. A similar pasture, lot V, was improved by discing and seeding to Italian rye grass and white Dutch clover and was grazed with ewes and lambs. An additional pasture, lot III, was grazed with cows, calves, ewes, and lambs. This last lot was added to the experiment because observations had shown that pastures grazed with cattle had good stands of clover but were weedy, while sheep pasture just across the fence had no weeds, very little clover, but a heavy growth of coarse grass that the sheep would not eat. Cattle and sheep had never been grazed together at Louisiana State University because of the rather pronounced opinion among cattlemen that calves become infested with stomach worms and other internal parasites from sheep. In order to get some data on this particular point, a group of cows and calves were weighed, grazed on the university cattle pasture, and used as a check against lot III. This group of cows and calves was called lot VI. The pasture gains of these six lots are shown in table II.

TABLE II. Summary of Pasture Gains Made by (a) Cattle and Sheep, (b) Cattle on Native Pasture, (c) Cattle on Improved Pasture, (d) Sheep on Native Pasture, and (e) Sheep on Improved Pasture[1], 1933.

Lot		I	II	III	IV	V	VI
Area, acres		11.25	11.25	17	7.833	10.9816	-------
Number of Animals per lot	Cows	11.7[2]	14.0[2]	12	-------	-------	12
	Calves	-------	-------	12	-------	-------	12
	Ewes	-------	-------	16/19[3]	16/20	33/39	-------
	Lambs	-------	-------	12	11	23[4]	-------
Initial weight per animal, pounds	Cows	-------	-------	806.2	-------	-------	785.8
	Calves	-------	-------	198.5	-------	-------	197.6
	Ewes	-------	-------	97.1	79.1	80.1	-------
	Lambs	-------	-------	33.1	37.7	32.3	-------
Final weight per animal, pounds	Cows	-------	-------	850.8	-------	-------	862.6
	Calves	-------	-------	415.7	-------	-------	426.2
	Ewes	-------	-------	94.4	75.7	80.2	-------
	Lambs	-------	-------	63.1	51.8	54.9	-------
Gain in weight per animal, pounds	Cows	-------	-------	44.6	-------	-------	76.8
	Calves	-------	-------	217.2	-------	-------	228.6
	Ewes	-------	-------	—2.7	—3.4	.1	-------
	Lambs	-------	-------	30.0	14.1	22.6	-------
Gain in weight per acre, pounds	Cows	148.6	264.8	31.5	-------	-------	-------
	Calves	-------	-------	153.3	-------	-------	-------
	Ewes	-------	-------	—1.9	—11.36	—6.39	-------
	Lambs	-------	-------	21.6	29.49	53.09	-------
Total pounds per acre		148.6	264.8	204.5	18.13	46.7	-------
Marketable gains per acre, pounds	Calves	-------	-------	153.3	-------	-------	-------
	Lambs	-------	-------	21.6	29.49	53.09	-------
Total		148.6	264.8	174.9	29.5	53.1	-------
Value of Marketable gains per acre at 7c per pound		$10.40	$18.51	$12.34	$2.07	$3.62	-------

[1] Grazing period: Cattle, lots I, March 30 to October 6.
II, March 30 to October 25.
III, April 19 to September 15.
Sheep, lots III, IV, and V, April 12 to October 13.

[2] Yearling heifers.

[3] Ewes were added to lots III, IV, and V on September 15, 1933.

[4] One lamb died August 10, in Lot V.

Lots I and II, as previously shown, produced 148.6 and 264.8 pounds of gain per acre. Lot III, grazed by cattle and sheep, produced 204.5 pounds of gain. The gains of these three lots are not comparable, because yearling heifers were used in lots I and II, while cows, calves, ewes, and lambs were used in Lot III. Yet lot III shows considerably more gain per acre than lot I, a comparable plot of land. The gains per acre of the sheep lots IV and V are 18.13 and 48.7 pounds respectively. This indicates the unprofitableness of grazing a river front pasture with sheep alone. The final weights of the calves in lots III and VI do not show any detrimental effects of grazing cattle and sheep together. On the contrary, the final weights of the lambs in lots III, IV and V indicate a beneficial effect for the lambs, the lot III lambs grazed with cattle averaging 63.1 pounds in weight, as compared to 51.8 and 54.9 pounds for the other two lots.

In 1934 the experiment was set up as a five lot experiment, starting March 26 and closing October 25, which made a 214 day grazing period for all lots. Cows and calves were used in lots I, II, and III and ewes and lambs in lots III, IV, and V. The data for 1934 are summarized in table III.

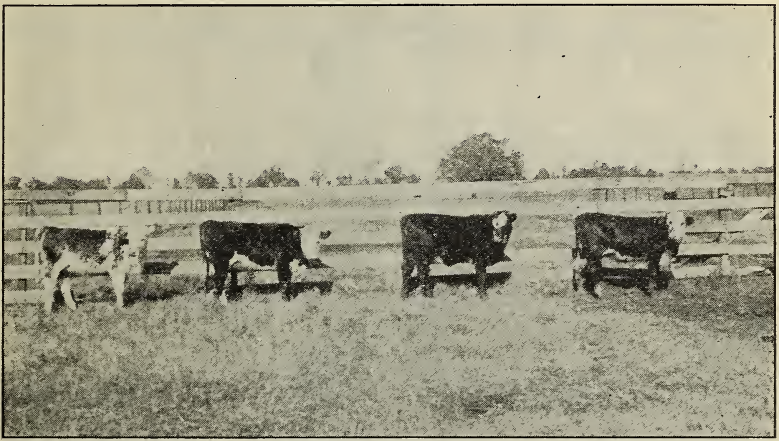

Figure 1—Calves averaging 477 pounds the first of November, produced on pasture grazed by cattle and sheep.

TABLE III. Summary of Pasture Gains Made by (a) Cattle, (b) Cattle and Sheep and (c) Sheep on Improved and Native Pasture, 1934. Grazing period, March 26 to October 25, 214 days.

Lot		I	II	III	IV	V
Area, acres		11.25	11.25	17.0	7.833	10.9816
Number of animals in lot	Cows	6	8	10	-------	-------
	Calves	6	8	10	-------	-------
	Ewes	-------	-------	12	6	15
	Lambs	-------	-------	10	5	14
Initial weight per animal, pounds	Cows	720	742	754	-------	-------
	Calves	109	107	101	-------	-------
	Ewes	-------	-------	70	73	76
	Lambs	-------	-------	15	13	15
Final weight per animal, pounds	Cows	843	880	914	-------	-------
	Calves	384	380	415	-------	-------
	Ewes	-------	-------	97	75	80
	Lambs	-------	-------	65	44	45
Gain in weight per animal, pounds	Cows	123	136	160	-------	-------
	Calves	275	273	314	-------	-------
	Ewes	-------	-------	27	2	4
	Lambs	-------	-------	50	31.1	30
Gain in weight per acre	Cows	65	116	94	-------	-------
	Calves	156	193	185	-------	-------
	Ewes	-------	-------	19	2	6
	Lambs	-------	-------	30	20	38
Total, pounds		221	309	328	22	44
Marketable gain per acre	Calves	156	193	184	-------	-------
	Lambs	-------	-------	30	20	38
Total marketable gain per acre		156	193	214	20	38
Value of marketable gain per acre at 7c per pound		$10.92	$13.51	$14.98	$1.40	$2.66

Figure 2—Grazing cattle and sheep together produced healthy 63 pound lambs at weaning time, few parasites, and good pasture utilization.

Both calves and lambs in lot III were heavier than the calves and lambs in the other lots, indicating the beneficial effect of grazing cattle and sheep together. The total gains per acre were 221 pounds, 309 pounds, 328 pounds, 22 pounds, and 44 pounds respectively for lots I, II, III, IV and V. The marketable gains per acre were 156 pounds, 193 pounds, 214 pounds, 20 pounds, and 38 pounds respectively for the five lots. These figures indicate the beneficial effect of discing and seeding pastures, the beneficial effect of grazing cattle and sheep together, and the poor return from grazing river front pasture with sheep alone.

The grazing project was set up in 1935 in a manner very similar to that used in 1934. Six cows and six calves were used in lot I, eight cows and eight calves in lot II, ten cows, ten calves, twelve ewes and seven lambs in lot III, six ewes and six lambs in lot IV, and eighteen ewes and nine lambs in lot V. The results are summarized in table IV.

TABLE IV. Summary of Pasture Gains Made by (a) Cattle, (b) Cattle and Sheep, and (c) Sheep on Native and Improved Pasture During the Grazing Season of 1935. March 28 to October 30—216 days.

Lot		I	II	III	IV	V
Area, acres		11.25	11.25	17.0	7.833	10.98
Number of animals per lot	Cows	6	8	10	-------	-------
	Calves	6	8	10	-------	-------
	Ewes	-------	-------	12	6	18
	Lambs	-------	-------	7	6	9
Initial weight per animal	Cows	724.7	717.0	767.9	-------	-------
	Calves	122.9	120.4	124.8	-------	-------
	Ewes	-------	-------	71.5	71.0	68.6
	Lambs	-------	-------	22.9	23.1	23.8
Final weight per animal, pounds	Cows	879.7	926.3	956.0	-------	-------
	Calves	397.8	419.2	477.3	-------	-------
	Ewes	-------	-------	91.6	67.7	69.8
	Lambs	-------	-------	61.0	42.1*	48.7*
Gain in weight per animal, pounds	Cows	155	209	188	-------	-------
	Calves	275	299	353	-------	-------
	Ewes	-------	-------	20	—3.3	1.2
	Lambs	-------	-------	38	19.0	25.0
Gain in weight per acre, pounds	Cows	82.67	148.80	110.71	-------	-------
	Calves	146.58	212.44	207.35	-------	-------
	Ewes	-------	-------	14.24	—2.55	—10.65
	Lambs	-------	-------	17.06	3.83	—10.65
Total		229.25	361.24	349.36	1.28	—21.30
Marketable gains per acre, pounds	Calves	146.58	212.44	207.35	-------	-------
	Lambs	-------	-------	17.06	3.83	—10.65
Total		146.58	212.44	224.41	3.83	—10.65

* Lot IV, two lambs died. Lot V, two ewes and eight lambs died.

Again the calves and lambs in lot III averaged heavier than the calves and lambs in the other lots. Lot III likewise produced more marketable gains per acre than any other lot, although lot II produced more total gain. The marketable gains for the five lots are 147 pounds, 212 pounds, 224 pounds, 3.83 pounds, and —10.7 pounds for lots I to V, respectively. The low gains in lots IV and V are due in part to deaths in these lots. Two lambs died in lot IV and two ewes and eight lambs in lot V died during the 1935 grazing season.

The amount of gains to the acre over the five years is shown in table V.

TABLE V. Gains per Acre of Pasture, 1931-1935.

Lot	I Cattle, Native Pasture	II Cattle, Improved Pasture	III Cattle & Sheep, Native Pasture	IV Sheep, Native Pasture	V Sheep, Improved Pasture
	Total Gains per Acre, Pounds.				
Year:					
1931	69.4	69.4			
1932	174.2	231.6			
1933	148.6	264.8	204.5	18.1	46.7
Av., '32-'33	161.4	248.2	204.5	18.1	46.7
1934	221.0	309.0	328.0	22.0	44.0
1935	229.0	361.0	349.0	1.28	—21.3
Av., '34-'35	225.0	335.0	339.5	11.64	11.7
	Marketable Gains per Acre, Pounds.				
1931	69.4	69.4			
1932	174.2	231.6			
1933	148.6	264.8	174.9	29.5	53.1
Av., '32-'33	161.4	248.2	174.9	29.5	53.1
1934	156.0	193.0	214.0	20.0	38.0
1935	146.0	212.4	224.4	3.8	—10.7
Av., '34-'35	151.0	202.5	219.2	11.9	13.7

Although the figures in this table are not comparable, due to the fact that in the first three years' work the lots I and II animals were either steers or heifers, while in the other lots and the two remaining years the animals used were cows and calves, ewes and lambs, or both, yet the figures do indicate the progressive increased productive capacity of lot III. In 1933 this pasture produced 204.5 pounds of gain; in 1934, 328 pounds of gain; and in 1935, 349 pounds of gain. The figures for marketable gains show a similar progressive increase in carrying capacity.

Another rather remarkable feature of this experiment is the long time effect of discing and seeding. At the close of this experiment, which was four seasons after the discing and seeding, the lot II pasture was still producing 57 per cent more total gains than lot I. At this time, lot III, which had not been improved but which was grazed with cattle and sheep, produced 52 per cent more total gains than lot I.

The results shown in this table indicated the futility of attempting to utilize riverfront pasture with sheep alone. Sheep, when grazed by themselves, do not make enough gains to be economical producers. Yet as indicated above, cattle and sheep together make a very good combination.

The initial weights, final weights, gains per individual, and marketable gains per acre of calves and lambs are summarized in table VI.

TABLE VI. Summary of Weights and Gains of Calves and Lambs.

Lot	I	II	III		IV	V
			1934			
		Calves			Lambs	
Initial weight, lbs.	109	107	101	15	13	15
Final weight, lbs.	384	380	415	65	44	45
Gain, pounds	275	273	314	50	31	30
Gain per acre	156	193	184	30	20	38
			214			
			1935			
Initial weight, lbs.	123	120	125	23	23	24
Final weight, lbs.	398	419	477	61	42	49
Gain, pounds	275	299	353	38	19	25
Gain per acre	147	212	207	17	3.8	—10.7
			224			
	Average, 1934-1935.					
Initial weight, lbs.	116	114	113	19	18	20
Final weight, lbs.	387	400	446	63	43	47
Gain, pounds	275	286	339	56	25	28
Gain per acre	151	203	196	24	12	14
			220			

This table shows that the calves of lot II averaged heavier at weaning time than the calves of lot I, indicating a better pasture. The lot III calves averaged heavier than either the lot I or lot II calves, indicating better grazing in this pasture than in either of the other two pastures. Any pasture that produces 220 pounds of marketable gains to the acre and calves weighing 446 pounds at weaning time should be considered a good pasture.

Monthly Weights

The monthly weights of the cattle and sheep reflect to some extent the conditions of the pastures. The weights for 1934 are shown in table VII.

TABLE VII. Average Monthly Weights of Cows, Calves, Ewes, Lambs—1934.

Lot	I		II		III				IV		V	
Area, Acres	11.25		11.25		17.00				7.83		10.98	
Date	Cow lbs.	Calf lbs.	Cow lbs.	Calf lbs.	Cow lbs.	Calf lbs.	Ewe lbs.	Lamb lbs.	Ewe lbs.	Lamb lbs.	Ewe lbs.	Lamb lbs.
March 26	720	109	742	107	754	101	84.9	33.3	68.3	20.0	65.2	25.0
April 24	787	174	807	183	837	165	87.1	42.3	69.2	26.6	71.9	29.6
May 28	812	211	878	218	857	213	78.9	56.3	70.3	38.0	70.3	40.6
June 22	852	267	911	287	904	276	83.3	59.9	72.8	42.4	73.9	40.0
July 20	836	301	878	310	889	310	85.8	63.6	72.0	42.4	75.0	44.0
Aug. 19	819	331	848	333	875	345	90.5	64.7	72.8	41.2	76.4	43.1
Sept. 14	832	355	889	372	913	393	88.9	63.4	69.5	38.3	75.1	41.3
Oct. 13	841	385	886	381	916	420	91.8	64.0	75.1	40.0	75.1	41.7
Oct. 25	843	384	878	380	914	415	97.2	65.6	75.2	43.7	79.7	44.8
Gain, lbs.	123	275	136	273	160	314	17.6	50.9	2.5	31.1	10.1	29.5
Gain per acre, lbs.	65	156	116	193	94	185	19.0	30.0	2.0	20.0	6.0	38.0
Marketable gain per acre		156		193	215				20		38	
Total gain per acre, lbs.		221		309	328				22		44	

A study of this table shows that on July 20 there was little difference in the weight of the calves, but from this date to October 13, the lot III calves made considerably more gain than did the calves in the other two lots. However, after October 13 the calves in all three lots and the cows in lots II and III lost weight, indicating that the calves should have been sold about the middle of October for maximum returns.

The sheep did not respond to these grazing conditions the same as the cattle. On July 20 the lambs had reached near maximum weight and gained very little after this date. From July 20 to September 13 both the ewes and lambs were at a virtual standstill, but during the last six weeks period, from September 14 to October 25, there was some increase in weight of both ewes and lambs, indicating that the heat may have had something to do with the way sheep, especially lambs, gain during the summer months. The average monthly gains for 1935 are shown in table VIII.

TABLE VIII. Average Monthly Weights of Cows, Calves, Ewes, and Lambs. For the Grazing Season, 1935.

Lot	I		II		III				IV		V	
Area, Acres	11.25		11.25		17.00				7.83		10.98	
Date	Cow lbs.	Calf lbs.	Cow lbs.	Calf lbs.	Cow lbs.	Calf lbs.	Ewe lbs.	Lamb lbs.	Ewe lbs.	Lamb lbs.	Ewe lbs.	Lamb lbs.
March 28	725	123	717	120	768	125	72	23	71	23	69	24
April 25	792	163	816	161	847	177	80	30	70	27	69	23
May 24	814	202	849	202	887	228	81	42	70	37	73	34
June 20	827	235	868	244	916	274	81	48	66	38	67	32
July 18	817	283	843	278	895	332	88	55	70	41	66	34
Aug. 15	849	338	866	328	913	385	90	57	70	41	66	38
Sept. 13	860	370	914	374	956	438	90	58	68	42	66	42
Oct. 11	885	412	907	401	974	472	90	58	66	37	67	43
Oct. 30	880	398	926	419	956	477	92	61	68	42	70	49
Gain per acre, lbs.	83	147	149	212	111	207	14	17	—3	4	—11	—11
Marketable gain per acre, lbs.		147		212	224					4		—11
Total gain per acre, lbs.	229		361		349				1		—22	

Again the cattle weights indicate that lot I had reached its maximum production by October 11, but not lots II and III. Both of these lots continued to show increased gains until October 30. The lambs in lots III, IV, and V gained slowly after July 18, indicating that heat and summer parasites may have influenced these gains. These two tables indicate a general tendency towards

Figure 3—Grazing sheep alone on riverfront pastures results in poor pasture utilization, heavy death losses, and light weight lambs.

low gains during July and August, with an increase in gains during September and the first half of October. Good pastures may continue to produce gains until November, but the productive pasture period certainly does not extend far past this date.

PARASITIC STUDIES

Parasitic studies were carried on along with the grazing, first with sheep and later with cattle. The Mississippi station (50) had recommended drenching lambs regularly every two weeks during the growing season of the lambs in order to produce strong healthy lambs. The Louisiana station adopted this practice as standard and started an experiment in which part of the lambs were undrenched, a part drenched with a one per cent solution of bluestone (copper sulphate), and a third group drenched with a solution containing one per cent bluestone and one per cent Blackleaf 40 (nicotine sulphate).

Lamb Drenching Studies, 1932

The first drenching trial of this series was started on July 25, 1932. On this date 39 lambs were divided into three groups of thirteen each and marked for identification. After this date all lambs were handled as one group and received the same care with these exceptions: lot I received no stomach worm drench; lot II was drenched regularly every two weeks with a one per cent solution of bluestone; lot III was drenched regularly every two weeks with a solution containing one per cent of bluestone plus one per cent of copper sulphate. The rate at which the drenches were administered in lots II and III was 1.2 cubic centimeters for each pound live weight. In order to increase gains, it was thought advisable to supplement the pasture with grain.

The records of weight, gains, and feed consumption are summarized in table IX.

TABLE IX. Effect of Drench Upon the Weight of Lambs.
July 22 to October 20, 1932—90 days.

Lot	I	II	III
Lambs	13	13	13
Drench	None	Bluestone	Bluestone + Blackleaf 40
Period	90	90	90
Average Initial weight, lbs.	65	65	65
Average Final weight, lbs.	65	66	64
Average Gain, lbs.	0	1	—1
Average Daily Ration:			
Corn, grain whole ear	.62	.62	.62
Cottonseed meal	.15	.15	.15

Drench had no effect upon the live weight of these lambs. Incidentally, the lambs did not gain during this period, even though they were fed .77 pounds of feed in addition to good pasture. This was somewhat surprising, although subsequent results indicate that summer gains in lambs are frequently non-existent.

In order to get some indication of the effect of the drench upon internal parasites, samples of feces were obtained at random from four lambs in each of the three groups and examined for parasitic eggs. Fecal samples were taken on September 9, October 6, and October 20. The results of these examinations are found in table X.

TABLE X. Effect of Drench Upon Nematode Eggs Found in Feces of Lambs—1932.

Lot	I			II			III		
Drench	None			Bluestone			Bluestone plus Blackleaf 40		
Date	Sept. 9	Oct. 6	Oct. 20	Sept. 9	Oct. 6	Oct. 20	Sept. 9	Oct. 6	Oct. 20
Sample 1	11	34	73	4	13	12	3	0	0
Sample 2	97	7	21	5	8	6	7	9	6
Sample 3	12	9	15	3	2	3	9	11	28
Sample 4	44	99	155	Lost	146	84	2	12	12
Total	164	149	264	12	169	105	21	37	46
Average	41	37	66	4	42	26	5	9	11
Lot total		577			286			104	
Lot average		48			26			9	

Drenching reduced the average fecal egg count of the lambs in lots II and III. When taken as a lot average, the differences in fecal egg counts were quite marked, lot I being 48; lot II, 26; and lot III, 9.

Post Mortem Examination—1932

At the close of the grazing period, four lambs were picked at random, slaughtered, and their intestinal tracts examined for internal parasites. The results of this examination are summarized in table XI.

TABLE XI. Parasites Found in the Stomach and Intestines of Lambs—1932.

Lamb No.	Date Slaughtered	—Stomach Worm— Stomach	Small Intestine	Nodular Worm	Coccidia
	Lot I—No Drench				
125	November 1	+	—	+++	+
117	November 9	+	—	++	+
120	November 18	+	—	++	+
114	December 2	+++	++	+	++
	Lot II—Bluestone Drench				
172	November 1	+	—	++	+
101	November 9	+	—	+++	+++
105	November 18	+	+	++	+++
102	December 2	+	+	+	++
	Lot III—Bluestone-Blackleaf 40 Drench				
119	November 1	+	—	++++	+
116	November 9	+	+	++	+
113	November 18	+	—	++	+
108	December 2	+	—	+++	++

The most outstanding point brought out by these post mortem examinations is the relatively high infestation of nodular worms in all three lots. These thirty-nine lambs had been grazed on an eight acre pasture. This relatively intense grazing may account for the heavy infestation of nodular worms. Drench apparently had little effect upon stomach worm infestation.

Lamb Drenching Studies, 1933

The procedure on the lamb drenching studies was changed in 1933, as compared to 1932. In 1933 the lambs were grazed with their mothers throughout the grazing period and received no supplemental feed. Drenching was started on April 10 and continued until the close of the experiment on October 12, or a period of 185 days.

In this trial, thirty-one lambs were divided into three groups as follows: lot I, eleven lambs; lot II, eight lambs; and lot III, twelve lambs. As in the preceding year, the lot I lambs were undrenched, the lot II lambs were drenched with 1.2 cubic centimeters of a one per cent bluestone solution per pound live weight every fourteen days, while the lambs in lot III received a similar amount of a solution containing one per cent bluestone and one per cent Blackleaf 40. All three groups were grazed together on the same pastures. All ewes were drenched with the bluestone-Blackleaf 40 drench, and, as in all our drenching work, both the ewes and lambs were penned without feed for eighteen hours before drenching. The effect of the drench upon the liveweight of the lambs is shown in table XII.

TABLE XII. Summary of Weights and Gains of Lambs, 1933.

Lot		I		II		III	
Drench		None		Bluestone		Bluestone & Blackleaf 40	
No. lambs in lot		11		8		13	
Date	Period (days)	Weight lbs.	Gain lbs.	Weight lbs.	Gain lbs.	Weight lbs.	Gain lbs.
April 10	0	35.5	----	34.1	----	34.1	----
May 8	28	44.5	9.0	43.2	9.1	43.9	9.8
June 5	28	50.7	6.2	50.2	7.0	49.7	5.8
July 3	28	56.5	5.8	54.5	4.3	56.2	6.5
July 31	28	62.4	5.9	58.6	4.1	60.7	4.5
August 28*	28	58.0	—4.4	54.7	—3.9	58.6	—2.1
Sept. 25	28	59.2	1.2	56.2	1.5	58.8	.2
October 12	17	59.2	0	56.2	0	59.1	.3
Total gain			23.7		22.1		25.0

*The lambs were shorn during this 28-day period, which accounts for a part of this loss in weight.

Again drench had no effect upon weight or gain in weight of these lambs. The undrenched lambs made just as good gains as those drenched, and the small difference in the gains of the lot II and lot III lambs cannot be considered significant, consequently the conclusion that drench had no effect upon gains is valid. As in the previous year, the lambs made little or no gain after July. Fecal egg counts and post mortem examinations were made, as in the previous year. These figures are summarized in table XIII.

TABLE XIII. Fecal Egg Counts and Post Mortem Examinations of Lambs, 1933.

Lamb No.	Fecal Egg Counts		Post Mortem Examination — Stomach		Post Mortem Examination — Intestine		
	Aug. 12	Oct. 6	Stomach Worm	Nodular	Hook	Cooperia	Tape
			Lot I. No Drench.				
400			—	—	+	+++	
411		129					
343		108	+	+	—	++	10 immature
395	46						
348	46	44					
349	166	277	++++	—	—	+	
352	6		+	+	—	++	
356		198	+	—	—	+	
367			+++	—	—	—	
374			+	+	—	—	
377			—	+	—	—	
Total	264	756					
Average	66	151					
Lot total	1020						
Lot average	113						
			Lot II. Bluestone Drench.				
403		75					
405		66					
404		61	—	+	—	+	
346	112	26	—	—	—	+++	
350	3	0					
353		362					
359	239						
375		203					
Total	354	793					
Average	118	113					
Lot total	1147						
Lot average	115						
		Lot III.	Bluestone-Blackleaf 40 Drench.				
402		82	+	—	—	+	
405			+	—	—	—	
407		5	—	—	++	+	
341	6	200					
342	65		+	+	—	—	
344	4						
351			+	—	—	+	
357		3					
360	1		—	—	—	—	
363			—	+	—	—	
368			—	+++	+	—	
370		59	+	—	—	—	
Total	76	349					
Average	19	70					
Lot total	425						
Lot average	47						

Although there were quite wide variations, the bluestone-blackleaf 40 drench seems to have reduced the fecal egg counts in lot III to a rather low count; 47 eggs to the slide as compared to 115 and 113 eggs per slide for lots II and I, respectively. The post mortem examinations indicate that both bluestone and the bluestone-Blackleaf 40 solution were effective in reducing the number of stomach worms. This is particularly noticeable in lot III, where nine lambs were examined and none was heavily infested with stomach worms.

Lamb Drenching Studies, 1934

The 1934 lamb drenching studies were carried out under the same procedure as in 1933. Twenty-nine lambs were divided into three lots—ten lambs in lot I, ten in lot II, and nine lambs in lot III. The lot I lambs received no drench. The lot II lambs were drenched with bluestone, and the lot III lambs with the bluestone-Blackleaf 40. The rate of drenching was 1.2 cubic centimeters, as in the preceding years. The ewes were drenched with bluestone-Blackleaf 40. All three groups were grazed together on the same pastures. Drenching was started on March 28 and continued to October 25, 1934, a period of 210 days. The effect of the drench upon the gains in liveweight of the lambs is shown in table XIV.

TABLE XIV. Effect of Drench Upon the Weights and Gains of Lambs, 1934. March 28 to October 25—210 days.

Lot		I		II		III	
Drench		None		Bluestone		Bluestone & Blackleaf 40	
Lambs in lot		10		10		9	
Date	Period (days)	Weight lbs.	Gain lbs.	Weight lbs.	Gain lbs.	Weight lbs.	Gain lbs.
March 28	0	33.9	----	33.8	----	32.3	----
April 25	28	41.9	8.0	41.9	8.1	40.6	8.3
May 23	28	45.4	3.5	45.7	3.8	44.3	3.7
June 20	28	49.1	3.7	49.5	3.8	48.3	4.0
July 18	28	52.2	3.1	50.3	.8	49.8	1.5
August 15	28	51.3	— .9	50.1	—.2	48.9	—.9
Sept. 12	28	49.5	—1.8	48.6	—1.5	47.2	—1.7
October 10	28	46.4	—3.1	48.0	—.6	42.5	—4.7
October 25	14	53.1	6.7	51.5	3.5	48.8	6.3
Total gain		19.2		17.7		16.5	

Again there was no effect of drench upon the liveweights or gains in liveweight. And again the lambs failed to gain after July, until October 10. Drenching may have a beneficial effect, due to its reducing the number of parasites, but this beneficial effect, if any, was fully offset by the drench itself insofar as gains in liveweight are concerned. This is shown rather forcibly by the final weights and gains in weight of the lambs. These figures and their straight averages are shown in table XV. Drench had no effect either on the final weight or on the gain in weight of the lambs.

TABLE XV. Effect of Drench Upon Average Final Weights and Gains in Weight of Lambs, 1933-1934.

Lot	I	II	III
Average final weight—1933	59.2	50.2	59.1
—1934	53.1	51.5	48.8
Average	56.1	50.9	53.9
Average gain in pounds—1933	23.7	22.1	25.0
—1934	19.2	17.7	16.5
Average	21.5	19.9	20.8

The fecal egg counts and the results of the post mortem examination are shown in table XVI.

TABLE XVI. Fecal Egg Counts and Post Mortem Examination of Lambs, 1934.

Lamb No.	Nematode Eggs April 10	May 25	July 19	Sept. 13	Post Mortem Examination Stomach Worm	Whip Worm	Nodular Worm
		Lot I. No Drench.					
418	7	5	17		+	—	++++
430	0	402	8	0	—	+	+
417	2	79	24	4	—	—	+++
427	79	155	411	115	—	—	+++
441	288	6	3		—	+	+
424	64	2000	30	305	+	+	++++
426	4	114	41	30	—	+	+++
436	101	1	7	41	—	+	+
419	13	1	0	2	+	+++	+
438	1	5	21	4	+	—	+
Total	559	2768	562	501			
Average	56	277	56	63			
Lot total		4390					
Lot average		116					
		Lot II. Bluestone Drench.					
431	9	142	15	3	+	+	+++
416	28	37	77	52	+	+	+++
428		89	400		—	+	+
415	36	230	5	93	—	—	++++
420	19	124		8	—	+	++++
443	25	3	500	543	—	+	++++
413	7	280	5	0			
433	255	10	6		+	—	+
414		2	7	1	+	—	+
449		16	5	1	+	++	+
Total	379	933	1020	701			
Average	54	93	113	88			
Lot total		3033					
Lot average		89					
		Lot III. Bluestone-Blackleaf 40 Drench.					
442	71	101	600	49	—	+	++
434	167	440	117	30	—	+	+
437	26	32	4	26	—	—	+++
423		20			—	+	+++
447	44	700	16	283	—	+	+++
422	7	436		27	+	—	++
421	39	50	0				
440	132	100	45	13	—	—	++++
429		5	4	0	+	+	+
Total	486	1884	786	428			
Average	69	209	112	61			
Lot total		3584					
Lot average		119.5					

This table has some very interesting features. For example, on April 10, an average of all slides showed 59 nematode eggs per slide; on May 25, 206 eggs; on July 19, 91 eggs; and on September 13, 70 eggs. Is there any significance in these seasonal variations? If there is, then May appears to be the month in which lambs are most likely to become heavily infested with stomach worms. The light infestation in the subsequent months might indicate two things: (1) that sheep tend to rid themselves of internal parasites, and (2) that the hot, somewhat dry months of the summer and early fall are less favorable to parasitic infestation than is the spring. In lot I, lamb No. 424, for example, showed a high fecal egg count (2000) in May, but in July his fecal egg count was only 30. In this same lot, lamb No. 430 showed a fecal egg count of 402 in May, but only 8 in July. However, it may be that these fecal egg counts are not reliable indicators of parasitic infestation. This point will be discussed later.

Another rather interesting feature about this chart is the fact that on post mortem examination fourteen out of the twenty-nine lambs showed heavy infestations of nodular worms, two showed moderate infestations, and the remainder light infestation. From this it appears that nodular worms may be just as important as stomach worms, especially where sheep are pastured rather heavily on the same ground year after year.

There was some indication that drenching had some effect on the production of nematode eggs, but this effect was not consistent. The average egg counts by lots are shown in table XVII.

TABLE XVII. Nematode Eggs to the Slide by Lots and Years.

Lot Drench	I None	II Bluestone	III Bluestone-Blackleaf 40
	Eggs Per Slide		
Year:			
1932	48	26	9
1933	113	115	47
1934	116	89	120

From these figures one might question either (a) the effectiveness of these drenches or (b) the value of fecal egg counts as an indicator of stomach worm infestation. In this connection, it must be kept in mind that, particularly in 1934, most of the lambs in each of the three lots were heavily infested with nodular worms. Hence, it seems reasonable to believe that drench might be effective in controlling stomach worms, but not nodular worms, and that a count of nematode eggs would not be an indicator of the effectiveness of the drench unless a differentiation were made between the eggs of the various round worms. Such a differentiation is difficult to make.

GRAZING AS A METHOD OF CONTROLLING INTERNAL PARASITES IN LAMBS

The grazing and parasitic studies previously discussed were so arranged that the effect of grazing systems upon parasitic infestation could be studied. The effect of grazing systems upon the parasitic infestation of lambs will be discussed first. As was pointed out earlier in this bulletin, lot III, an unim-

TABLE XVIII. Fecal Egg Counts and Post Mortem Examination of Lambs as Affected by Grazing Systems, 1933.

Lamb No.	Fecal Egg Counts		Post Mortem Examination			
			Stomach		Intestine	
	August 12	October 6	Stomach Worm	Nodular Worm	Hook Worm	Cooperia
	Lot III. Cows, Calves, Ewes, Lambs.					
400			—	—	+	+++
402		82	+	—	—	—
403		75				
404		61	—	—	—	+
405		66				
407		5	—	—	++	+
411		129				
Total		418				
Average		70				
	Lot IV. Ewes and Lambs, Unimproved Pasture.					
342	65		+	+	—	—
344	4					
348	46	44				
349	166	277	++++	—	—	+
350	3	0				
357		3				
359	239					
375		203				
405		66				
Total	523	593				
Average	87	99				
Lot total	1116					
Lot average	93					
	Lot V. Ewes and Lambs, Improved Pasture, Rotated Weekly.					
341	6	200				
343		108	+	+	—	++
345	46					
346	112	26	—	—	—	+++
351			+	—	—	+
352	6		+	++	—	++
353		362				
356		198	+	—	—	+
360	1		—	—	—	—
363			—	+	—	—
367			+++	—	—	—
368			—	+++	+	—
370		59	+	—	—	—
374			+	+	—	—
377			—	+	—	—
Total	230	894				
Average	38	79				
Lot total	1124					
Lot average	102					

TABLE XIX. Fecal Egg Counts and Post Mortem Examinations of Lambs as Affected by Grazing Systems, 1934.

Lamb No.	Fecal Egg Counts April 10	May 25	July 19	Sept. 13	Post Mortem Examination Stomach Worms	Whip Worms	Nodular Worms
Lot III. Cows, Calves, Ewes, and Lambs—Unimproved Pasture.							
413	7	280	5	0			
419	13	1	0	2	+	+++	+
421	39	50	0				
433	255	10	6		+	—	+
436	101	1	7	41	—	+	+
438	1	5	21	4	+	—	+
441	288	6	3		—	+	+
429		5	4	0	+	+	+
414		2	7	1	+	—	+
449		16	5	1	+	++	+
Total	705	377	58	49			
Average	88	38	6	7			
Lot total		1189					
Lot average		54					
Lot IV. Ewes and Lambs, Unimproved Pasture.							
417	2	79	24	4	—	—	+++
418	7	5	17		+	—	++++
430	0	402	8	0	—	+	+
431	9	142	15	3	+	+	+++
442	71	101	600	49	—	+	++
Total	89	729	664	56			
Average	22	146	133	14			
Lot total		1538					
Lot average		81					
Lot V. Ewes and Lambs, Improved Pasture.							
415	36	230	5	93	—	—	++++
416	28	37	77	52	+	+	+++
420	19	124		8	—	+	+++
422	7	436		27	+	—	++
424	64	2000	30	305	+	+	++++
426	4	114	41	30	—	+	+++
427	79	155	411	115	—	—	+++
428		89	400		—	+	+
434	167	440	17	30	—	+	+
437	26	32	4	26	—	—	+++
440	132	100	45	13	—	—	++++
443	25	3	500	543	—	+	+++
447	44	700	16	283	—	+	+++
423		20			—	+	+++
Total	665	4480	1546	1525			
Average	51	320	131	127			
Lot total		8216					
Lot average		168					

TABLE XX. Fecal Egg Counts and Post Mortem Examinations of Lambs as Affected by Grazing Systems, 1935.

Lamb No.	Fecal Egg Counts			Post Mortem Examination						
				Stomach	Small Intestine			Lg. Intest.		Head
	April 22	June 10	Sept. 3	Stomach Worm	Hook worm	Nod. worm	Tape worm	Whip worm	Nod. worm	Bots
Lot III. Cows, Calves, Ewes, and Lambs on Unimproved Pasture.										
500	1	43	21	+	+	—	—	—	+	—
508	244	20	80	—	+	+	—	+	+	—
525	23	115	110	+	+	—	—	+	+++	—
527	185	27	90	++	—	—	—	+	+	—
528	69	6	47	+	—	—	—	+++	++	—
600	31	48	90	—	—	+	—	—	++	—
504	124	23	88	+	—	—	—	+	++	2
Total	577	282	526							
Average	82	40	75							
Lot total		1385								
Lot average		66								
Lot IV. Ewes and Lambs on Unimproved Pasture.										
502	12	62	90	++++	+	—	—	—	—	—
506	175	106		++++	+	—	—	—	++	2
514	198	27	200	+++	—	++	—	+	++	—
720	62	90	199	+++	+	—	—	+	+	—
526	32	421			Died August 18, 1935					
529	4	15	90	++++	+	—	+	—	+++	*10/11
Total	483	721	579							
Average	81	121	145							
Lot total		1783								
Lot average		111								
Lot V. Ewes and Lambs on Improved Pasture.										
501	80	202			Died September 13, 1935.					
503		92		++++	+	—	—	+	++	* 7/25
510	180				Died June 20, 1935.					
517	198	103	99	+	+	+	—	++	++	—
516	230	30			Died August 17, 1935.					
521	195	214			Died July 18, 1935.					
735	199	792	0	—	—	—	—	—	++	*10/11
531	64	541			Died August 19, 1935.					
532	7	1043			Died July 18, 1935.					
Total	1155	3017	99							
Average	144	377	50							
Lot total		4271								
Lot average		237								

*Killed on date given.

proved pasture, was grazed with cows, calves, ewes, and lambs; lot IV, an unimproved pasture, was grazed with ewes and lambs; and lot V, an improved pasture, was grazed with ewes and lambs. Lot V was divided into four pastures and the ewes and lambs rotated weekly. In this way, the sheep were on a new pasture each week. It was thought that such a system would permit the clover to reseed itself and perhaps produce a better pasture. Such a system, however, meant a rather heavy concentration of sheep on a small area of ground at all times. This heavy concentration may account for some of the differences in parasitic infestation. The results of the fecal egg counts and post mortem examination of the lambs for the year 1933 are shown in table XVIII.

This table shows the lot III lambs which were grazed with cattle to have fewer nematode eggs in their feces than the lambs of lot IV, and the lambs of lot IV to have fewer eggs in their feces than those of lot V. The heavier concentraton of sheep on a small area of land may have accounted for the higher nematode egg counts of the feces of the lambs in this last lot. It is also rather interesting to note from the post mortem examinations that one of the two lambs examined in lot IV had a heavy infestation of stomach worms, and that several of the lambs in lot V were infested with cooperia. Table XIX shows the results of the fecal egg counts and post mortem examinations of the lambs for 1934.

Again the lot III lambs had fewer nematode eggs in their feces than did the lot IV lambs, and the lot IV lambs had fewer than the lot V lambs. The post mortem examinations showed the lot III lambs to be comparatively free from nodular worms, while the lot IV and V lambs were relatively heavily infested with nodular worms. Evidently grazing sheep with cattle resulted in a marked reduction in nodular worms. We believe this reduction to be due to (1) fewer sheep to an acre of land, and (2) the closer grazing of the coarse grasses by the cattle thereby reducing the shade on and the moisture in the soil.

The procedure was changed slightly in 1935. In the previous years, two lambs out of three in each lot were drenched, the third lamb was undrenched. Drenching, as shown in the drenching studies, had failed to produce heavier lambs at market time than no drenching. The undrenched lambs had averaged just as heavy in October as the drenched lambs. The ewes in all lots had been drenched regularly every 14 days. In 1935, all ewes and lambs were drenched at the time they were weighed into the lots, but neither the ewes nor the lambs were drenched after that, even though they became extremely emaciated from parasite infestation. Instead, they were killed and examined for parasites. In some cases, the lambs died and were not examined. The 1935 results are shown in table XX.

Again the lot III lambs had fewer nematode eggs in their feces than did the lot IV lambs, and the lot IV lambs had fewer than the lot V lambs. The lot III had relatively few stomach worms, few hook worms and nodular worms in the small intestine, but a medium infestation of nodular worms in the large intestine. The lot IV lambs were all heavily infested with stomach worms and carried moderate to heavy infestations of nodular worms. Two lambs out of this lot of six died, or were killed because of emaciated condition during the course of the experiment. In lot V, only one lamb of the nine lived to the end of the experiment. This lamb showed only a slight infestation of internal parasites, which may have been due to natural resistance, grazing habits, or some other cause. These figures show that healthy, vigorous lambs can be raised without drenching, when grazed with cattle, but that heavy stocking of sheep on small areas of land is decidedly not economical.

TABLE XXI. Comparison of the Effects of Drench and Grazing Systems Upon the Final Weights and Fecal Egg Counts of Suckling Lambs*.

Lot	I	II	III
Lambs	21	18	21
Deaths	0	0	0
	Effects of Drench.		
Final Weights:	No Drench	Bluestone	Bluestone-Blackleaf
1933	59.2	56.2	59.1
1934	46.4	48.0	42.5
Average	52.8	52.1	50.8
Fecal Egg Counts:			
1933	113	115	47
1934	116	89	120
Average	115	102	84
	Effects of Grazing Systems.		
Lot	III	IV	V
Lambs	24	20	38
Deaths	0	1	8
Final Weights:			
1933	63	52	55
1934	65	44	45
1935	61	42	48
Average	63	46	49
Fecal Egg Counts:			
1933	70	93	102
1934	54	81	168
1935	66	111	237
Average	63	95	166

*The yearling lambs were not included in this comparison.

From these data it is quite apparent that grazing cattle and sheep together was more effective in producing heavy weight lambs than drench. Likewise, it is quite evident that, aside from low pasture production, internal parasites make the utilization of pasture by sheep alone a very hazardous enterprise.

EFFECT OF GRAZING CATTLE AND SHEEP TOGETHER UPON THE INTERNAL PARASITES OF CALVES

Many cattlemen and veterinarians in Louisiana have claimed that sheep and cattle cannot be grazed together because the calves become infested with stomach worms from the sheep. Data have already been presented showing the effect of grazing cattle and sheep together upon the live weight gains and production per acre of pastures grazed by cattle, cattle and sheep, and by sheep alone. Data concerning the parasitic infestation of calves grazed on cattle pastures and on cattle and sheep pastures will now be presented.

In 1933, post mortem examinations were made on the twelve calves in lot III and on twelve comparable calves in the regular cattle pasture, which were called lot VI. These data are presented in table XXII.

TABLE XXII. Parasitic Infestation of Calves Raised on Regular Cattle Pasture and on Cattle and Sheep Pasture.

Calf No.	—Post Mortem Examination— Stomach Worms	Hook Worms	Calf No.	—Post Mortem Examination— Stomach Worms	Hook Worms
Lot III. Cows, Calves, Ewes, Lambs.			Lot VI. Regular Cattle Pasture		
51	+	+	52	+++	++
267	+	—	56	+++	++
275	—	+	58		
276	++	+	57		
284	+	++	277		
285	+++	+	283	—	—
288	+	+	289	+	++
299	+	++	291	+	++
307	++	+	300	++	++
316	+	+	301	++	+
318			313		
320			310	++	++

These data do not show any indication of heavier infestation of stomach or hook worms in the calves as a result of grazing cattle and sheep together. In 1934, post mortem examinations were made on all calves in lots I, II, and III. The results of these examinations are shown in table XXIII.

TABLE XXIII. Results of Post Mortem Examination of Calves, 1934.

Calf	Stomach Worm	Hook Worm	Nodular Worm	Whip Worm
Lot I. Cows and Calves, Unimproved Pasture.				
361	+	—	+	—
386	++	+	++++	+
411	—	+	+++	+
395	—	—	+	—
379	+	—	+	—
400	—	+	+++	—
Lot II. Cows and Calves, Improved Pasture.				
402	—	—	+	+
404	—	++	+++	—
368	+	+	+	+
412	+	—	+++	—
366	+	—	++	—
393	++	+++	+++	—
390	++	+++	+++	+
355	+	++	+++	+
Lot III. Cows, Calves, Ewes, and Lambs, Unimproved Pasture.				
403	—	+++	+	—
405	+	+	—	—
408	—	—	+++	+++
371	+	+	+	—
378	—	+	+	—
385	+	+	+	—
384	—	—	+	+
399				
397	+	+	++	++
376				

From these data sheep could not be accused of giving the calves stomach worms, because the heavier infestations of stomach worms occurred in the other two lots. Likewise, the heavier infestations of hook worms and nodular worms occurred in the other two lots.

Parasitic studies of the three lots of calves were planned for 1935, but unfortunately, through a misunderstanding at the abattoir, no data were obtained on the lot I and II calves. Data were obtained, however, on the lot III calves, and on a group of eight calves from the regular cattle pasture. These data are presented in table XXIV.

TABLE XXIV. Parasitic Infestation of Calves Raised on Regular Cattle Pasture and on Sheep and Cattle Pasture.

	——Post Mortem Examination——					——Post Mortem Examination——			
Calf No.	Stomach Worm	Hook Worm	Nodular Worm	Whip Worm	Calf No.	Stomach Worm	Hook Worm	Nodular Worm	Whip Worm
Lot III.	Cows, Calves, Ewes, Lambs.				Lot —.	Regular Cattle Pasture.			
464	—	—	+	+	530	—	+	—	—
448	—	+	+	—	505	—	+	+	+
478	+	+	—	—	501	++	+	++	+
476	—	+	+	—	473	+	+	++	—
451	—	—	+	—	555	—	++	+	+
467					431	+	+	+	+
480	—	+	+	—	463	+	+	—	—
483					434	—	+	—	—
458	+	—	+	—					
470	—	—	+	—					

Again there is no evidence that grazing cattle and sheep on the same pasture increases parasitic infestation of the calves. On the contrary, grazing these two classes of animals together under the conditions of this experiment resulted in fewer parasites, in both calves and lambs. These results may have been due to (1) fewer animals of each type on an area of ground, or (2) the fact that cattle and sheep are not hosts to the same internal parasites, including the stomach worm.

FORAGE STUDIES

During the grazing seasons of 1934 and 1935 forage studies were made from protected and unprotected plats during the grazing season. Three of these plats were located in different areas of each lot and three cuttings of one meter square were taken at different seasons of the year—spring, summer, and fall. A third group of protected plats was left uncut until fall. Consequently, the forage on three groups of plats was studied as follows: (a) unprotected plats cut at three seasons of the year; (b) protected plats cut at three seasons of the year; and (c) protected plats cut in the fall. The studies of the unprotected plats are of considerable significance because they indicate the progressive effect of grazing different classes of animals. In this connection it should be kept in mind that these forage studies were not started at the same time the experiment was started, hence the differences in forages may be due in part to grazing previous to the time of the forage studies. The data for the unprotected plats for the year 1934 are shown in table XXV.

TABLE XXV. Forage Studies of Unprotected Grazed Plats, 1934.
(All figures in per cent.)

Lot	I	II	III	IV	V
June Cutting					
Dallis Grass	11.68	7.05	35.48	22.03	28.14
Bermuda Grass	47.19	51.76	8.78	44.59	37.11
Broom Sedge	-----	-----	-----	-----	-----
White Dutch Clover	.95	.42	10.81	.41	8.04
Weeds and Miscellaneous	40.18	40.77	44.93	32.97	26.71
August Cutting					
Dallis Grass	9.92	8.37	72.43	63.81	41.61
Bermuda Grass	56.57	69.94	14.70	30.78	47.86
Broom Sedge	-----	-----	1.40	-----	-----
White Dutch Clover	-----	-----	-----	-----	.25
Weeds and Miscellaneous	33.51	18.98	11.47	5.16	10.20
November Cutting					
Dallis Grass	8.88	4.68	53.94	42.03	28.50
Bermuda Grass	74.57	84.55	15.44	8.92	30.08
Broom Sedge	.41	-----	-----	18.77	8.64
White Dutch Clover	-----	.74	.32	-----	.11
Weeds and Miscellaneous	16.14	9.08	30.08	28.85	31.14
Average of all Cuttings.					
Dallis Grass	10.75	7.12	58.42	37.38	31.70
Bermuda Grass	53.89	64.05	13.23	34.00	38.64
Broom Sedge	.06	-----	-----	3.56	1.56
White Dutch Clover	.53	.32	3.76	.22	4.59
Weeds and Miscellaneous	34.77	27.36	24.54	24.50	23.22

Probably the most outstanding features of this table are (1) the predominance of Bermuda grass in lots I and II, (2) the high percentage of Dallis grass in lot III, and (3) the broom sedge showing up in lots IV and V. These differences were most pronounced in the fall and could be seen by walking through the pastures. The data for the unprotected plats for 1935 are shown in table XXVI.

TABLE XXVI. Forage Studies of Unprotected Grazed Plats, 1935.
(All figures in per cent.)

Lot	I	II	III	IV	V
June Cutting.					
Dallis grass	6.16	2.05	28.07	8.83	18.02
Bermuda grass	20.16	19.62	23.77	42.64	41.55
Broom sedge	.18	-----	-----	30.74	10.58
White Dutch clover	1.00	18.03	20.18	-----	5.66
Weeds	5.80	11.90	4.10	.60	2.50
August Cutting.					
Dallis grass	2.67	9.71	30.80	.02	26.10
Bermuda grass	25.50	58.30	3.30	2.00	19.12
Broom sedge	.10	-----	.10	76.50	24.10
White Dutch clover	.03	.22	.33	-----	.32
Weeds	32.70	11.70	.27	.05	2.20
November Cutting.					
Dallis grass	2.60	3.10	55.80	4.60	52.30
Bermuda grass	36.60	39.00	28.70	3.90	3.60
Broom sedge	-----	-----	-----	80.00	21.00
White Dutch clover	-----	-----	-----	-----	-----
Weeds	17.20	9.10	.80	.20	1.90
Average of All Cuttings.					
Dallis grass	3.40	6.90	36.10	2.00	37.70
Bermuda grass	27.60	47.70	14.20	10.40	20.00
Broom sedge	1.10	-----	-----	68.80	19.90
White Dutch clover	.20	2.70	6.00	-----	1.50
Weeds	17.10	9.20	.80	.20	2.00

Again, as in table XXV, the most outstanding differences shown by this table are the predominance of Bermuda grass in lots I and II, the preponderance of Dallis grass in lot III, and the high percentages of broom sedge in lots IV and V.

Another difference which tables XXV and XXVI do not bring out is the fact that lots I, II, and III were grazed rather close, while lots IV and V had a heavy growth of coarse grass which the sheep would not eat. All five lots were mowed at the end of the grazing period, but only lots IV and V had enough material to rake. The figures for 1934 and 1935 are shown in table XXVII.

TABLE XXVII. Forage Produced in Excess of Grazing (Mostly Coarse Grasses).

Lot	I	II	III	IV	V
1934, pounds	0	0	0	7.930	26.345
1935, pounds	0	0	0	40.585	32.065

These figures give some idea of the amount of forage on a riverfront pasture which is not utilized by grazing with sheep alone. This large amount of forage which is not utilized makes it unprofitable to graze riverfront pastures with sheep alone. Parasitic infestation makes it impractical to put enough sheep on these pastures to keep the forage grazed down to the point where the forage is green and tender. A combination of cattle and sheep proved most effective from the standpoint of both pasture utilization and parasitic infestation.

The data obtained from the forage studies of the protected plats are shown in tables XXVIII, XXIX, XXX, and XXXI. The average chemical composition of the pasture plants found in the experimental plots in the October, 1935, cutting is shown in table XXXII.

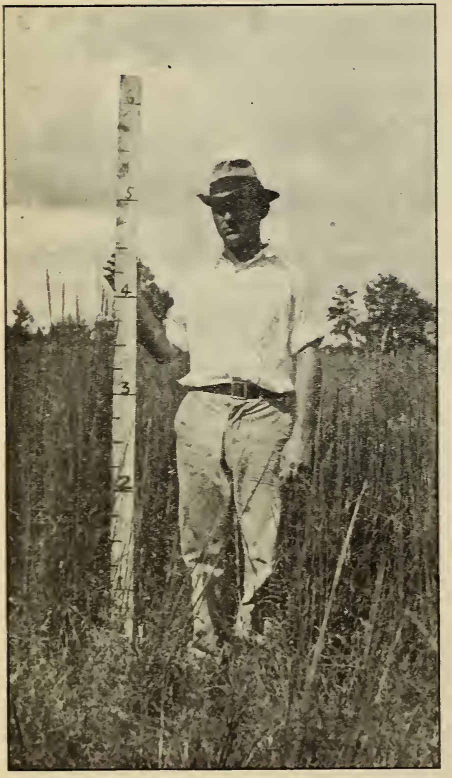

Figure 4—Sheep do not utilize coarse pasture grasses.

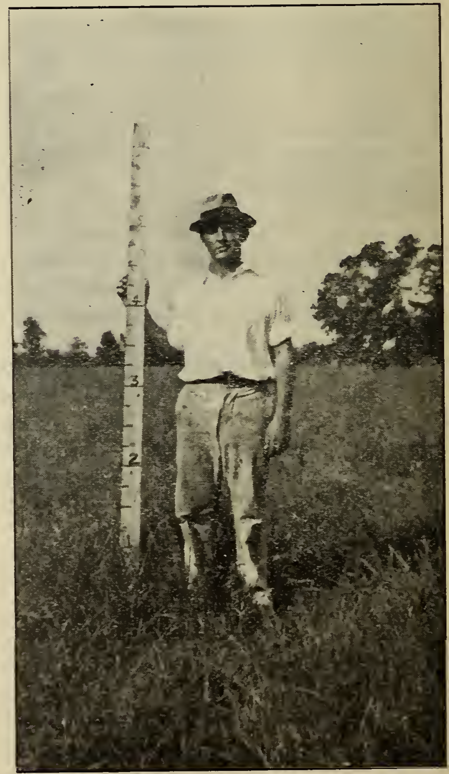

Figure 5—Grazing sheep and cattle together results in good grazing and few weeds.

TABLE XXVIII. Forage Studies of Protected Ungrazed Plats, 1934. (All Figures in Per Cent.)

	Lot I	Lot II	Lot III	Lot IV	Lot V
June Cutting.					
Dallis grass	11.05	11.80	53.87	45.90	21.35
Bermuda grass	21.58	41.84	2.86	18.03	22.54
Broom sedge	-----	-----	-----	-----	-----
White Dutch clover	1.65	-----	29.74	.13	31.47
Weeds	-----	-----	-----	-----	-----
August Cutting.					
Dallis grass	39.29	24.77	90.58	67.39	70.03
Bermuda grass	39.72	29.24	1.50	17.48	20.73
Broom sedge	-----	-----	-----	-----	-----
White Dutch clover	-----	-----	.33	-----	2.90
Weeds	-----	-----	-----	-----	-----
November Cutting.					
Dallis grass	28.43	7.14	86.56	21.75	48.76
Bermuda grass	33.22	47.84	1.33	11.12	13.09
Broom sedge	10.91	-----	-----	41.41	17.36
White Dutch clover	-----	-----	-----	-----	-----
Weeds	2.06	13.23	.07	.55	-----
Average of All Cuttings.					
Dallis grass	26.07	14.81	77.02	47.22	42.83
Bermuda grass	31.39	37.65	1.93	15.62	20.02
Broom sedge	3.42	-----	-----	13.08	3.53
White Dutch clover	.57	-----	10.41	.03	15.73
Weeds	.65	4.65	.01	-----	.11

TABLE XXIX. Forage Studies of Protected Ungrazed Plats, 1935. (All Figures in Per Cent.)

	Lot I	Lot II	Lot III	Lot IV	Lot V
June Cutting.					
Dallis grass	19.19	5.08	64.06	19.52	34.61
Bermuda grass	8.48	12.55	.41	3.37	4.81
Broom sedge	1.55	-----	.21	41.11	3.22
White Dutch clover	30.54	28.69	11.35	5.21	37.98
Weeds	26.10	41.85	11.38	12.35	13.32
August Cutting.					
Dallis grass	46.38	41.95	91.28	30.28	47.50
Bermuda grass	14.01	12.25	.78	2.17	12.55
Broom sedge	2.20	-----	-----	60.96	.18
White Dutch clover	.21	.32	.68	.25	.48
Weeds	30.91	7.01	4.10	.89	1.26
November Cutting.					
Dallis grass	56.91	10.54	88.20	7.64	43.88
Bermuda grass	15.65	47.86	1.11	1.78	11.96
Broom sedge	13.45	-----	-----	76.61	17.71
White Dutch clover	-----	.11	.08	-----	-----
Weeds	4.84	.44	4.29	.27	.87
Average of All Cuttings.					
Dallis grass	43.76	22.59	84.34	20.90	40.14
Bermuda grass	12.52	14.72	.75	2.79	8.25
Broom sedge	3.85	-----	.08	52.07	3.22
White Dutch clover	.07	13.64	.32	3.01	21.01
Weeds	26.98	23.36	7.37	7.65	8.23

TABLE XXX. Forage Studies—Protected, Nine Months Growth, 1934. (All Figures in Per Cent.)

	Lot I	Lot II	Lot III	Lot IV	Lot V
Dallis grass	23.93	29.41	48.25	1.21	4.98
Bermuda grass	25.78	22.37	.09	3.71	33.13
Broom sedge	3.46	-----	1.50	79.60	8.90
White Dutch clover	-----	.43	-----	-----	.01
Weeds	42.20	30.10	37.19	15.08	34.56

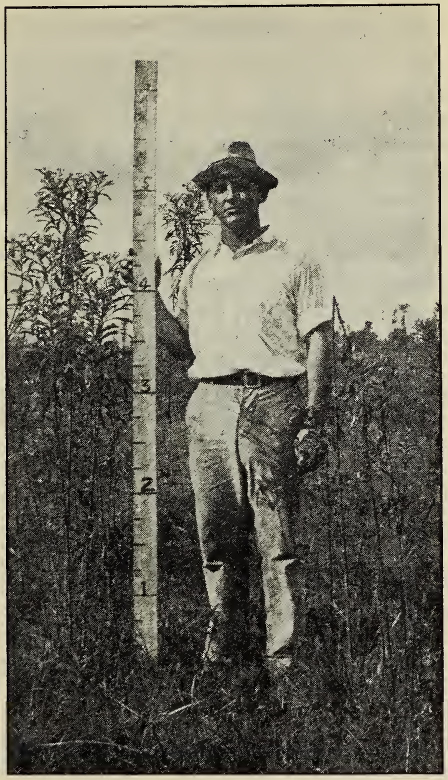

Figure 6—Weeds are found in pastures grazed exclusively by cattle.

TABLE XXXI. Forage Studies—Protected, Nine Months' Growth, 1935. (All Figures in Per Cent.)

	Lot I	Lot II	Lot III	Lot IV	Lot V
Dallis grass	5.34	2.73	34.00	5.30	39.95
Bermuda grass	1.64	2.00	5.05	.75	12.49
Broom sedge	4.24	-----	5.76	37.30	.37
White Dutch clover	-----	-----	-----	-----	-----
Weeds	67.97	23.43	46.97	30.52	15.95

TABLE XXXII. Average Chemical Analyses of Pasture Plants Cut in October, 1935.

Plant	Protein	Ether Extract	N.F.E.	Fiber	Ash	CaO	P_2O_5
Pasaplum	4.60	1.15	44.69	34.66	7.72	.478	.368
Coco grass	6.63	1.87	49.34	26.38	9.03	.209	.233
Bermuda	5.25	1.20	48.43	31.00	6.94	.412	.401
Sedge grass	3.49	1.36	43.52	39.74	4.31	.226	.241
Foxtail Meadow grass	3.63	1.33	41.48	37.77	8.52	.518	.397
Water grass	4.77	1.45	44.94	38.15	3.69	.377	.313

SUMMARY

A riverfront pasture was divided into five lots and grazed as follows: lot I, unimproved, grazed with cattle; lot II, improved by discing and seeding with station rye grass, white Dutch clover, and black medic, grazed with cattle; lot III, unimproved, grazed with sheep and cattle; lot IV, unimproved, grazed with sheep; and lot V, improved by discing and seeding with station rye grass and white Dutch clover, grazed with sheep. The results obtained may be summarized as follows:

1. Discing and seeding resulted in marked improvement of cattle pastures, but not so marked gains of sheep pastures. When grazed by steers or heifers, the unimproved cattle pasture produced an average of only 161 pounds of gain to the acre, while the improved cattle pasture produced an average of 248 pounds of gain to the acre. When grazed with cows and calves, ewes and lambs, or both, the acre gains were as follows: Lot I, cattle, unimproved pasture, 225 pounds; lot II, cattle, improved pasture, 335 pounds; lot III, cattle and sheep, unimproved pasture, 339 pounds; lot IV, sheep, unimproved pasture, 12 pounds; lot V, sheep, improved pasture, 12 pounds.

The marketable gains per acre, that is, the gains made by calves and lambs, are as follows: Lot I, unimproved pasture, calves, 151 pounds; lot II, improved pasture, calves, 203 pounds; lot III, unimproved pasture, calves and lambs, 220 pounds; lot IV, unimproved pasture, lambs, 12 pounds; lot V, improved pasture, lambs, 14 pounds.

These figures show the marked gains from improving pasture for cattle, as well as the beneficial effect of grazing sheep and cattle together. They also show the futility of attempting to make economical gains from grazing riverfront pasture with sheep alone.

2. The average final weights of the calves and lambs of the various lots were: Lot I, unimproved pasture, calves, 387 pounds; lot II, improved pasture, calves, 400 pounds; lot III unimproved pasture, calves 446 pounds, lambs 63 pounds; lot IV, unimproved pasture, lambs, 43 pounds; lot V, improved pasture, lambs, 47 pounds.

These figures show that improvement of pasture results in marked improvement of calf weights, but not in lamb weights. They also show the heaviest average weight for calves and lambs to have been produced on a sheep and cattle pasture.

3. Both cows and calves continue to gain on riverfront pasture until the middle of October or the first of November.

4. Drenching studies with lambs indicate that neither a one per cent bluestone solution nor a solution containing one per cent bluestone plus one

per cent nicotine sulphate, when administered at the rate of 1.2 c.c. to the pound live weight, is effective in reducing stomach worm and other parasitic damages. The average weaning weights of drenched and undrenched lambs are as follows: Lot I, check lot, undrenched, 52.8 pounds; lot II, bluestone drench, 52.1 pounds; lot III, bluestone plus nicotine sulphate drench, 50.8 pounds.

5. Grazing sheep with cattle at the rate of one cow and calf plus one ewe and lamb to approximately one and three-fourths acres resulted in heavier lambs and no death losses than did grazing lambs and ewes alone. This system of grazing was more effective in controlling internal parasites in lambs than was drenching. The lambs grazed with cattle averaged 63 pounds at weaning time; those grazed on sheep pastures averaged 46 pounds and 49 pounds respectively.

6. Grazing cattle and sheep together did not increase the parasitic infestation of calves. On the contrary, calves raised as were the ones in lot III had fewer internal parasites than calves raised in the regular cattle pastures.

7. Pastures grazed exclusively with cattle showed a preponderance of Bermuda grass; the pasture grazed with cattle and sheep showed a comparatively higher percentage of Dallis grass; those grazed by sheep alone had higher percentages of broom sedge, a grass the sheep refused to eat. These differences became very marked during the last year of the experiment.

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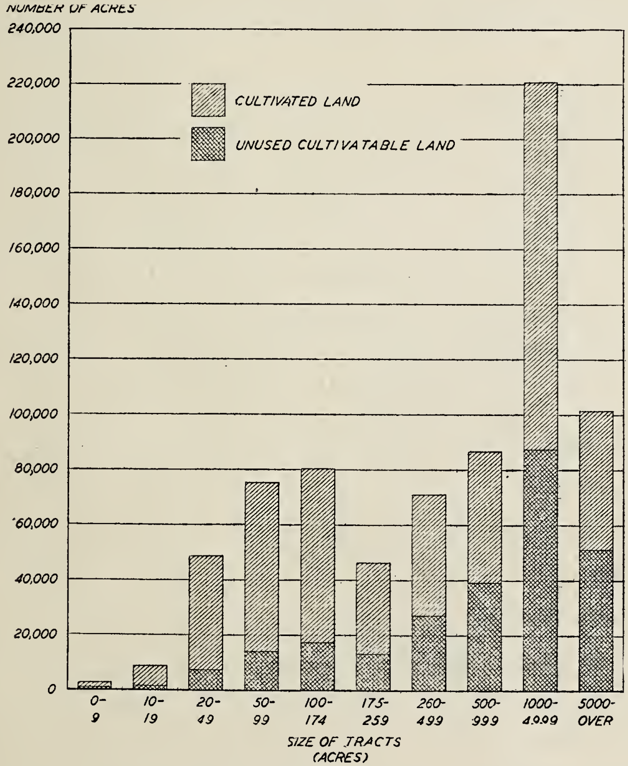
OCTOBER, 1936 LOUISIANA BULLETIN NO. 280

Some Characteristics of Cultivatable Land in the Sugar Cane Area of Louisiana

By
R. J. SAVILLE
AND
A. L. DUGAS



Unused cultivatable land in the sugar cane area is very closely associated with size of tract.

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

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SOME CHARACTERISTICS OF CULTIVATABLE LAND IN THE SUGAR CANE AREA OF LOUISIANA

R. J. SAVILLE
AND
A. L. DUGAS[1]

INTRODUCTION

This report, largely statistical in content, presents some characteristics of the land and its present and potential uses as found by a survey in thirteen parishes forming the heart of the "Sugar Bowl."

The investigation, started in 1935, was the outcome of an increasing interest on the part of numerous public and private agencies for accurate factual information about the area. When a study, such as this one, originates from the interest of diverse groups it probably has two distinct aims to meet. In one group are those interested in the study from the purely investigational standpoint, which may be satisfied by description. In another group are those whose interest is in purposive analysis which will manifest itself in recommendations and assumptions that create a new and different picture from what now exists. It seemed quite possible and desirable, in launching this study, that both points of view were necessary for an understanding of the area as a land utilization problem worthy of consideration for resettlement.

The large amount of statistical material contained in the report is in response to the constant demand upon the writers for interpretations based upon acquired data rather than from academic discourses. If the data are adequately presented, those individuals who are more familiar with the intricate working of the economic and technical mechanism of the area under study may be able to give a more tangible scientific application to the trend of affairs from day to day than is possible otherwise. It will permit a greater freedom in the interpretation of the data. The more durable human value lies, not in the description of the static state, but in the helpful adjustments that can be made use of in restoring to human use a larger portion of the area under study.

Since a study of the sugar cane area would be closely identified with the use of idle cultivatable lands for increased sugar cane production, it seems imperative to establish certain positions taken by the writers so that the reader may not be unwarned of what to expect. A study of the sugar area for the purpose of getting an accurate description of what exists is not to be confused with the projection of possibilities assumed from that description.

The content of this report, therefore, is a presentation of the statistical material obtained largely by interview with owners and operators of 6,672 tracts of land, and brief interpretations of the data and methods used. Economic and social justifications are neither heralded nor condemned. It is hoped that a clearer and more comprehensive picture of the area may be useful in developing a program that would make the best use of the existing resources.

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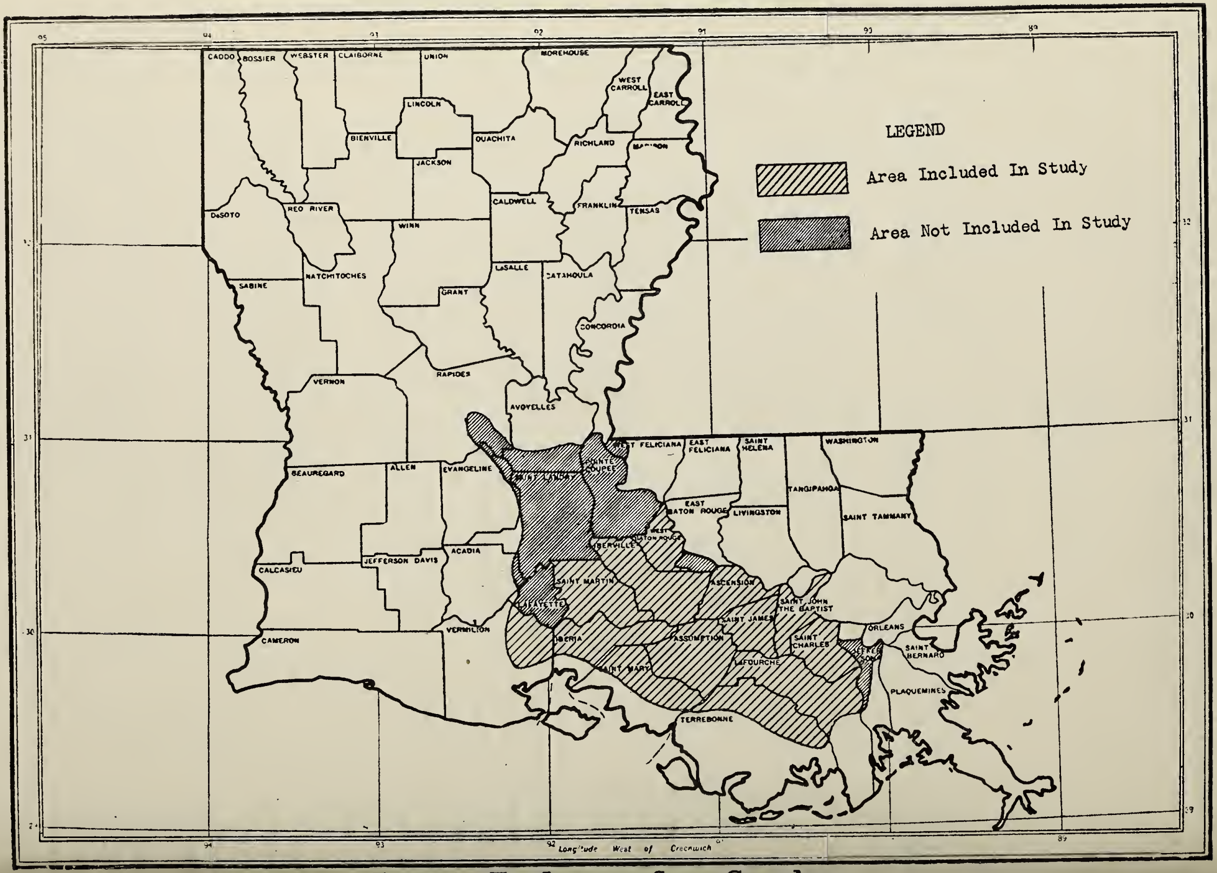

FIGURE 1. THE LOUISIANA SUGAR CANE AREA

COOPERATING AGENCIES

The conduct of this investigation and the preparation of the report were made possible through a cooperative arrangement among the Emergency Relief Administration of Louisiana, the Works Progress Administration, the Sugar Section of the Agricultural Adjustment Administration, and the Louisiana Agricultural Experiment Station.[2]

For the preparation of this report, interpretations and conclusions the writers alone are responsible.

AREAS CONSIDERED

Sugar cane production in Louisiana and cultivatable land formerly devoted to sugar cane conform to certain natural rather than political boundaries. This makes it difficult to designate the area accurately by parishes. However, Figure 1 shows the relative boundaries of the region and the parishes studied. As a problem in the characteristics of cultivatable land that was idle in 1934 one is confronted with two major areas from the standpoint of possible land use by crops. In the area forming the heart of the "Sugar Bowl," the idle cultivatable land was, in the past, in the prevailing system of farming of the present time. This area will be referred to subsequently as the major area.

On the rim of the "Sugar Bowl," the idle land may have resulted from changes in the acreages of cotton, rice, and truck crops as well as of sugar cane. Each of these commercial crops has contributed to the present area of idle land as will be shown later. This will be referred to as the minor area, though in area and in cultivatable land it differs very little from the major area. The field investigation for this report was restricted to the major sugar cane area. A brief interpretation from census data is presented for the minor area.

METHOD USED

The statistical material of this report was obtained largely by personal interviews of enumerators with land owners and land operators at which time the information was recorded in a field schedule. A complete enumeration of all agricultural land was attempted. It is recognized, however, that such a goal was not attained as a later explanation will show. In order to facilitate enumeration the names and addresses of all sugar cane growers who participated in the program of the Agricultural Adjustment Administration in 1934 were listed by wards, with information concerning the size of holdings, acres of land in cultivation, acres in cane, and the name and address of the landlord for tenant-operated places made available for the field supervisor and enumerators. Also, the addresses and land holdings of all resident and non-resident land owners reported in the 1934 parish assessment rolls were provided. In addition to the above sources of land ownership identification, the junior author, who supervised the field enumeration and the editing of the schedules, obtained personal information from county agents and other agricultural workers, particularly about location and ownership of the larger holdings, and more particularly, those that were not occupied at the present time.

---

[2] Funds for the employment of field enumerators and clerical workers were furnished by the Emergency Relief Administration of Louisiana and the Works Progress Administration. Funds for the maintenance of the field and office work were furnished by the Sugar Section of the Agricultural Adjustment Administration. The Louisiana Agricultural Experiment Station furnished supervisory personnel throughout the study.

Acknowledgement should be made to the many people of the area who gave so willingly of their time and factual information during the conduct of the study, and to those who have had a part in the tabulation and analysis of the data.

These sources of information were used to follow closely the work of the field enumerators and assisted materially in a more complete enumeration of the land. The tracts of land covered by the field schedules were compared with the information showing land ownership and sugar cane production. Also, the schedules for the larger holdings were verified by persons long familiar with the area in order to avoid, if possible, any omissions. While information was not obtained on all of the agricultural land, this is probably the most complete enumeration that has ever been made for many of the items under consideration.

Preliminary field tests at the beginning of the investigation showed that neither time nor funds would permit a thorough report on every tract of land, the people on it, the physical organization, and certain financial transactions. Since the major purpose of the study was to get a fairly complete inventory of the cultivatable land and certain characteristics about its use, schedules were prepared that would permit a rapid enumeration of the items essential for the major purposes and, at the same time, permit a large volume of information for a part of the tracts. From this smaller sample it would be possible to make certain approximations for the universe and in so doing add to the fund of information forthcoming from the study. To meet these variable conditions two additional schedules were devised to supplement the long schedule adopted at the start of the study. The three types of schedule used may be designated for present description and future reference, as (1) sample schedule, (2) regular short schedule, and (3) regular long schedule. A brief description will indicate the use made of each type of schedule.

The sample schedule was used for all tracts of less than 100 acres in total land area and of less than 20 acres in cultivation with five acres or less devoted to sugar cane, or tracts that were distinctly off type in respect to these three characteristics, or when the informant was not thoroughly acquainted with the property. In order to be classified as eligible for a sample schedule and be comparatively typical the tract must come within the limits of the three characteristics. This schedule contained information on size of tract, acres in cultivation, actual and desired acres in sugar cane, people employed or living on the tract, and work stock used.

The regular long schedule was replete with details on many items of importance to some individuals or agencies of the area. They were used for what may be called a random sample of the interviews. Either all of this type of schedule were taken by the enumerators in one day, or one or two a day, during the stay in a given area, except for two areas, West Baton Rouge and St. Martin. In these two parishes a much larger sample was obtained. The greater detail covered certain characteristics of the labor supply and people living on the tracts, resources of the plantation, probable rehabilitation needs and costs, indebtednesses, delinquencies, and possibilities of fuller utilization of the resources.

The regular short schedule contained the items considered most important for a comprehensive study of the area, and about which estimating from a random sample would not be possible or desirable. The degree of detail was greatly reduced in the short schedule. Most of the information was obtained through the use of this type of schedule.

This use of different types of schedule made it necessary to estimate for certain items from existing schedules the approximate totals for all schedules. Thus, the writers have done part of the task usually left to the individual when the data reported are from a partial enumeration. The data arrived at by this technique will be so indicated in the course of the discussion, so that the reader need not be confused between total actual count and estimates from partial count.

Further explanation of particular procedure and methods will be found in the body of the report at such points where the data are discussed.

Certain terminology that is used frequently through the discussion is indicated in the classification of the data for analysis. It is necessary to keep the distinctions clearly in mind for the sake of a proper appreciation of the many comparisons presented.

CLASSIFICATION FOR ANALYSIS

The major division of the data has been into land-use classes. In one class are all tracts that had no idle cultivatable land in 1934.[3] This class included all of the tracts on which full surface cultivation of land was already attained, though the desired degree of intensity in land use may or may not have been reached.

In a second class are the tracts that had all of the cultivatable land idle in 1934. The land may have been grazed or clipped, or temporarily abandoned. People may or may not reside on the property. Likewise, there may or may not be work stock and improvements available for operation. By far the smallest number of tracts were in this class, though their future use is of considerable importance to the area.

A third class included all tracts with any part of the cultivatable land idle. No division of tracts in this class according to the proportion of the cultivatable land idle in 1934 was attempted.

After establishing these land-use classes according to idle cultivatable land, the data were grouped according to type of schedule or acres in the tract. Four groups were recognized. The sample schedules formed one group. The regular long and short schedules were divided into three size groups. The class limits of these size groups were as follows: 1 to 99.9 acres, 100 to 999.9 acres, and 1,000 acres and over. The largest tract reported was 49,240 acres. The first size group and the sample schedule group included mostly family-sized farms. The largest size group contained the typical, large plantations. While this grouping by size of tracts was quite arbitrary, it permitted a more complete analysis and understanding of certain important characteristics being observed. Such a differentiation is highly important in considering resettlement possibilities, or the natural return of the land to agricultural use.

Size groups based upon total acreage of land rather than land available for cultivation might be challenged. It is always possible that the former category may include cut-over swamp land, marsh lands, and timber lands, so that the normal association between size of tract and acreage of cultivatable land is disrupted. This possibility the writers felt would cause no great difference in the results obtained, since this was partly corrected by using sample schedules for the tracts that were noticeably off type in the proportion of land not cultivatable.

The size and land-use classifications permit comparisons between land-use classes for all tracts and tracts of each size group. Also, for any land-use class, comparisons between size groups are available. Each characteristic brought into consideration is analyzed in so far as these groupings permitted. Some of the more important characteristics considered are the size of tract, area in cultivation, area of cultivatable land, actual and desired acreage in cane, actual number of regular workers and anticipated needs, actual number of people involved and probable change, present work stock numbers and extra needed for changes in cane acreage, labor efficiency, cane yield and volume of cane production, and others. Additional techniques will be referred to and explained as they are brought into use.

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[3] A tract is all of the land operated or managed as a unit, or owned as a unit.

COMPARABILITY WITH CENSUS DATA

Personal enumeration is open to bias both on the part of the interviewer and of the person interviewed. Also, there is the possibility of omission when complete enumeration is attempted. Every effort was used to guard against both bias and omission as much as possible. The data have not been changed in any way for assumed biases, nor have the writers any objective proof of a noncompensating bias in the data as they were obtained or analyzed.

Most individuals like to compare sample enumeration with a complete enumeration if possible. Fortunately, the data for this study were obtained for the same crop year and at about the same time of year as the census enumeration for 1934. This permits a comparison of items that were similarly identified, such as the land in farms, acres in cane, crop land harvested, and idle cultivatable land. The census enumeration follows political subdivision boundaries whereas the present study followed more closely the intensive sugar cane producing areas. For direct test, therefore, it is necessary to limit the comparison to those parishes in which sugar cane production is prevalent throughout the parish.

In eleven of the thirteen parishes in which data were obtained conditions were such that direct comparison with the census is possible. The two parishes not comparable are Vermilion and St. Martin, where only a part of each parish grows sugar cane. The characteristics of the other crops in these parishes seriously interfere in the classification of the land for comparative purposes. In these eleven parishes which include Ascension, Assumption, Iberia, Iberville, LaFourche, St. Charles, St. James, St. John, St. Mary, Terrebonne, and West Baton Rouge, the census showed only 90 per cent as much land in farms as was found in the survey; 97 per cent as much crop land harvested; 93 per cent as much sugar cane for all purposes; and 64 per cent as much idle cultivatable land. Only for LaFourche Parish did the census report more land in farms than was found in the survey. In six parishes the census reported more crop land harvested than was found in the survey. The census report on sugar cane acreage exceeded that of the survey in four parishes. In every parish the acreage of idle cultivatable land (idle or fallow land, and plowable pasture) as indicated by the census was far below that of the survey.

For three items in the comparison close agreement was present and the departure was uniform in direction. For idle cultivatable land a wide variation appeared. This item has been highly controversial and presented one of the most important problems to be solved by the study. The item of idle land was given as careful attention as other questions, even to the extent of locating unoccupied tracts. The writers believe the care used by the enumerators in this survey in numerating all items was as good as was possible in census enumeration. An examination of the data suggests the possibility that a more complete enumeration of land in farms would, at the prevailing ratio of cultivatable land to total land, have given the additional idle land. It is highly probable that census enumerators did not locate absentee land owners of idle properties as carefully as we have done. Furthermore, a full enumeration of the universe should show even more land than was found in our partial enumeration, even though it was practically complete, because it is known that a few tracts were not included.

It appears highly probable that approximations for the complete area on the basis of the sample data will be accurate within the boundaries from which the sample was drawn. It should not be assumed that such accuracy is applicable in the border area. With the soundness of the sample fairly well established let us proceed to the interpretation of the data.

TABLE 1. NUMBER AND PER CENT DISTRIBUTION OF TRACTS WITH AND WITHOUT IDLE CULTIVATABLE LAND, ACCORDING TO THE SIZE OF TRACT, 1934

Total acres in tract	*Tracts without idle cultivatable land*		*Tracts with idle cultivatable land*		*All tracts*		
	Number of tracts	*Per cent of all tracts*	*Number of tracts*	*Per cent of all tracts*	*Number of tracts*	*Per cent of of all tracts*	*Cumulative per cent*
0	32	0.9	1	0.1	33	0.5	0.5
3	304	8.1	117	3.9	421	6.3	6.8
10	493	13.2	239	8.1	732	11.0	17.8
20	1,283	34.4	688	23.3	1,971	29.5	47.3
50	853	22.9	658	22.3	1,511	22.7	70.0
100	456	12.3	470	16.0	926	13.9	83.9
175	141	3.8	197	6.7	338	5.0	88.9
260	88	2.4	224	7.6	312	4.7	93.6
500	39	1.0	144	4.9	183	2.7	96.3
1,000	33	0.9	185	6.3	218	3.3	99.6
5,000 and over	4	0.1	23	0.8	27	0.4	100.0
TOTAL........	3,726	100.0	2,946	100.0	6,672	100.0	....

LAND USE AND SIZE DISTRIBUTION

The tracts of land varied in size from 1 to 49,240 acres with 63 per cent of them between 9 and 100 acres. The most frequently reported sizes were from 20 to 50 acres. The distribution of all tracts according to land use, and the per cent of all tracts in each size group, are presented in Table 1. Seventy per cent of the tracts were less than 100 acres in size. Only 3.7 per cent were 1,000 acres or larger.

A very marked difference appeared between the size distribution for tracts with no idle land and those with a part of the present cultivatable land idle. The proportion of small tracts with idle land is much lower; and of larger tracts, 100 acres and over, much higher than for properties without idle land. This difference is quite significant in considering the possible ways in which the idle land of the area may be returned to agricultural use.

Classification by number of tracts alone, however, gives quite a different picture from what was found for total acres of land. Whereas 56 per cent of the tracts had no idle land in 1934, they represented only 27 per cent of the land area. It is possible to have large areas of idle land and yet find most of the present operators unable to make any use of it because of the location, or size in which it is held. By cross comparisons of both land use and size, a more detailed picture of the land-use problem may be attained. Such is possible from Table 2.

More than half of the tracts had no idle land. Eight per cent were idle properties, and 36 per cent were tracts with part of the cultivatable land idle. The idle properties as a class had relatively the same proportion of the land area as of the tracts. The tracts with no idle land were relatively small, having only 27 per cent of the land area, but 56 per cent of the tracts. They were only half the average size for all tracts. The relatively large tracts were partly operated. In this land-use class there were slightly over one-third of all tracts, but they contained 65 per cent of the land area. Idle land is closely associated with size of tract.

Each size group may be appraised similarly to that just made for all size groups as some very significant relationships appear in the different land-use classes. Again reference to Table 2 is necessary. On tracts with no idle land the comparatively small owners or operators, who have about 80 per cent of the tracts, have only 33 per cent of the land area. This may be compared with the large plantations that made up only one per cent of the tracts and have 29 per cent of the land area. A more marked dominance in number of small tracts relative to their land area existed in the partly idle and idle land-use classes than was found for fully operated tracts. The dominance of small holders in number only indicates one of the most important characteristics of the land-use problem to be dealt with. Since 56 per cent of all tracts, and 63 per cent of the relatively small tracts are now fully tilled, the solution is largely one of more intensive use of present cultivated land, and the return to agricultural use of comparatively large tracts as they exist at present or through subdivision into smaller units of family-sized farms.

Since our major interest is with idle land, a further examination of these tracts is presented. The average size of the idle tracts was 187 acres compared with 197 acres for all tracts. The tracts varied from 2 to 8,057 acres. The average for tracts covered by sample schedules was identical with that for all tracts. The small tracts covered by regular schedules had 51 acres per tract compared with 52 acres for all tracts of similar size. The plantations, 1,000 acres and over, were much smaller than average, being 2,069 compared with 2,861 for all tracts. In size of tract there was no marked difference between the idle properties and other properties. Compared

TABLE 2. ACREAGE AND PER CENT OF LAND IN DIFFERENT LAND-USE CLASSES, ACCORDING TO SIZE OF TRACT, 1934

Size of tract	*Tracts with no idle cultivatable land*			*Tracts with all of cultivatable land idle*		
	Number of acres	*Per cent of total acres*	*Per cent of total tracts*	*Number of acres*	*Per cent of total acres*	*Per cent of total tracts*
Sample schedules	34,215	10	36	6,418	6	43
Regular schedules						
0-99	84,187	23	45	7,558	8	28
100-999	136,112	38	18	41,661	42	25
1,000 and over	105,145	29	1	43,452	44	4
TOTAL	359,659	100	100	99.089	100	100
Per cent of total acres and all tracts		27	56		8	8

Size of tract	*Tracts with part of cultivatable land idle*			*All tracts*		
	Number of acres	*Per cent of total acres*	*Per cent of total tracts*	*Number of acres*	*Per cent of total acres*	*Per cent of total tracts*
Sample schedules	13,452	2	15	54,085	4	29
Regular schedules						
0-99	53,495	6	41	145,240	11	42
100-999	237,312	29	36	415,085	32	25
1,000 and over	549,542	64	8	698,139	53	4
TOTAL	853,801	100	100	1,312,549	100	100
Per cent of total acres and all tracts		65	36		100	100

with their respective size group, the larger tracts were relatively small, on the average, and the tracts of medium size were relatively large.

In size, the tracts with part of the cultivatable land idle varied from 1 to 49,240 acres, and averaged 354 acres. Compared with the other land-use classes this average was about four times that of tracts with no idle land and twice that of tracts with all idle land. This marked variation was due to the presence of a relatively large number of plantations in this class. While the tracts in this land-use class were relatively large, on the average, the variations were not wide for any size group.

This analysis by land-use classes according to size of tract has indicated the dominance of the small tracts in the fully operated land-use class of the medium and large sized plantations in partly idle and idle land-use classes. Land in tract, however, is only one characteristic of the land area. The degree to which land is used at present or may be used is yet to be discussed.

CULTIVATABLE LAND

The cultivatable land includes both the land in cultivation and the idle cultivatable land. The main interest in this study is in the restoration of cultivatable land to agricultural use or more intensive use. Of the 1,312,549 acres in farms, 57 per cent was classed as cultivatable. Only 37 per cent of this land was in cultivation in 1934, leaving 20 per cent, or 259,278 acres of idle cultivatable land. Further characteristics of the land in cultivation and the idle land will now be presented.

According to land-use groups, 30 per cent of the cultivatable land was in tracts fully operated; seven per cent was in idle tracts; and 63 per cent (tilled land 35 per cent, and idle land, 28 per cent) was in tracts partly idle. About 56 per cent of the cultivatable land in tracts now partly operated is in cultivation. These tracts have nearly four times as much area for potential expansion as is available in idle tracts.

It might be well to examine the distribution of this cultivatable land as to size of present holdings. The small tracts, those of about 100 acres or less, had 18 per cent of the cultivatable land of which 11 per cent was in fully tilled tracts, one per cent in idle tracts, and six per cent in partly idle tracts (Table 3). The large plantations, those with 1,000 acres or more in the tract, had 44 per cent of the cultivatable land. Seven per cent of their cultivatable land was in fully tilled tracts, two per cent in idle tracts, and 35 per cent in partly idle tracts. Those tracts of 100 to 1,000 acres had 38 per cent of the total cultivatable land, of which 25 per cent was already in cultivation.

The data obtained in this study will, no doubt, be drawn upon heavily by parish planning agencies in the future for working out a program of land use. While the objective in this report is to treat the area as a unit, it may be helpful for this broader perspective to show the extent to which each parish has land available for cultivation, and the proportion of it idle at the present time (Table 4). Relatively high proportions of idle land were found in St. Charles, Ascension, St. James, and St. Mary. The low proportions were in Vermilion, Iberia, and St. Martin. The eastern area seems to have curtailed crop production to a much greater extent than in the western area, with the exception of St. Mary Parish. The acreage of idle land in the 13 parishes touched by this study together with estimates for adjoining parishes is shown in Figure 2.

Since idle cultivatable land occupies such an important place in an area where rotation practices frequently make use of all of the cultivatable land, it seems desirable to explain what this land was used for before becoming idle, and when it became idle. Two sources of information, that obtained in this survey and the census reports,

Table 3. The Distribution of Cultivatable Land in Tracts of Different Size, According to Land-Use Class, 1934

Land-use class	*Sample schedules and tracts of less than 100 acres*		*Tracts of 100 to 1,000 acres*		*Tracts of 1,000 acres and over*		*Total all tracts*	
	Number of acres	*Per cent of total acres*	*Number of acres*	*Per cent of total acres*	*Number of acres*	*Per cent of total acres*	*Number of acres*	*Per cent of total acres*
Tracts with no idle cultivatable land	81,340	11	91,603	12	52,544	7	225,487	30
Tracts with part of cultivatable land idle								
Cultivated	29,607	4	93,227	12	139,111	19	261,945	35
Idle	15,666	2	67,763	9	121,819	16	205,248	28
Tracts with all of cultivatable land idle	8,454	1	28,423	4	17,153	2	54,030	7
Total, all tracts	135,067	18	281,016	38	330,627	44	746,710	100
Total cultivated tracts	110,947	15	184,830	25	191,655	26	487,432	65
Total idle tracts	24,120	3	96,186	13	138,972	18	259,278	35

TABLE 4. DISTRIBUTION BY PARISHES OF IDLE AND OPERATED CULTIVATABLE LAND AND THE PER CENT OF THE CULTIVATABLE LAND IDLE, 1934

Parish	*Idle cultivatable land, acres*	*Operated cultivatable land, acres*	*Total cultivatable land, acres*	*Per cent of cultivatable land idle*
Ascension	35,619	29,823	65,442	54
Assumption	21,358	46,713	68,071	31
Iberia	16,734	78,124	94,858	18
Iberville	24,987	41,379	66,366	38
Lafourche	20,200	54,454	74,654	27
St. Charles	20,765	8,723	29,488	70
St. James	21,119	25,520	46,639	45
St. John	6,106	17,777	23,883	26
St. Martin	13,640	52,568	66,208	21
St. Mary	40,953	49,113	90,066	45
Terrebonne	19,660	39,304	58,964	33
Vermilion	4,200	20,762	24,962	17
West Baton Rouge	13,937	23,172	37,109	38
TOTAL	259,278	487,432	746,710	35

may be used for this inquiry. Information on the previous use of land and when the land became idle was obtained for all regular schedules. The main difficulty encountered was in those instances when ownership or management had changed since the land became idle, or where the person supplying the information was not familiar with the details of the technical operation of the tract. Census reports for the crop years 1909, 1919, 1924, 1929, and 1934 may be used to measure changes. The most pronounced weakness of these data is the failure to get at the highest or lowest acreages unless they coincide with the census year. Each of these methods may be explained and the results shown.

In the attempt to account for idle cultivable land from the reports of census enumeration it must be assumed that the difference between the highest acreage and present acreage (1934) of each crop is the amount of land that has been released by that crop either to become idle, to be used by other crops, or to revert to uncultivated land in farms. The same assumption was used for total land in farms and total land in cultivation (land available for crop). Between 1910 and 1934 the decrease in all land in farms for the 13 parishes included in this survey was 214,974 acres. For the same period the decrease in the minor area (nine parishes bordering the major area) was 366,907 acres. Obviously, land went out of farms or else the abandonment of many properties made information about them unavailable for enumerators.

Since land in farms includes all classifications of land, a more accurate measure should be found in the total land available for cultivation. This includes land harvested, idle, fallow, crop failure, and plowable pasture. For the major area the difference between the peak acreage so classified and the acreage in 1934 was 148,292 acres, or 57.2 per cent of the amount reported for the same parishes in this survey.

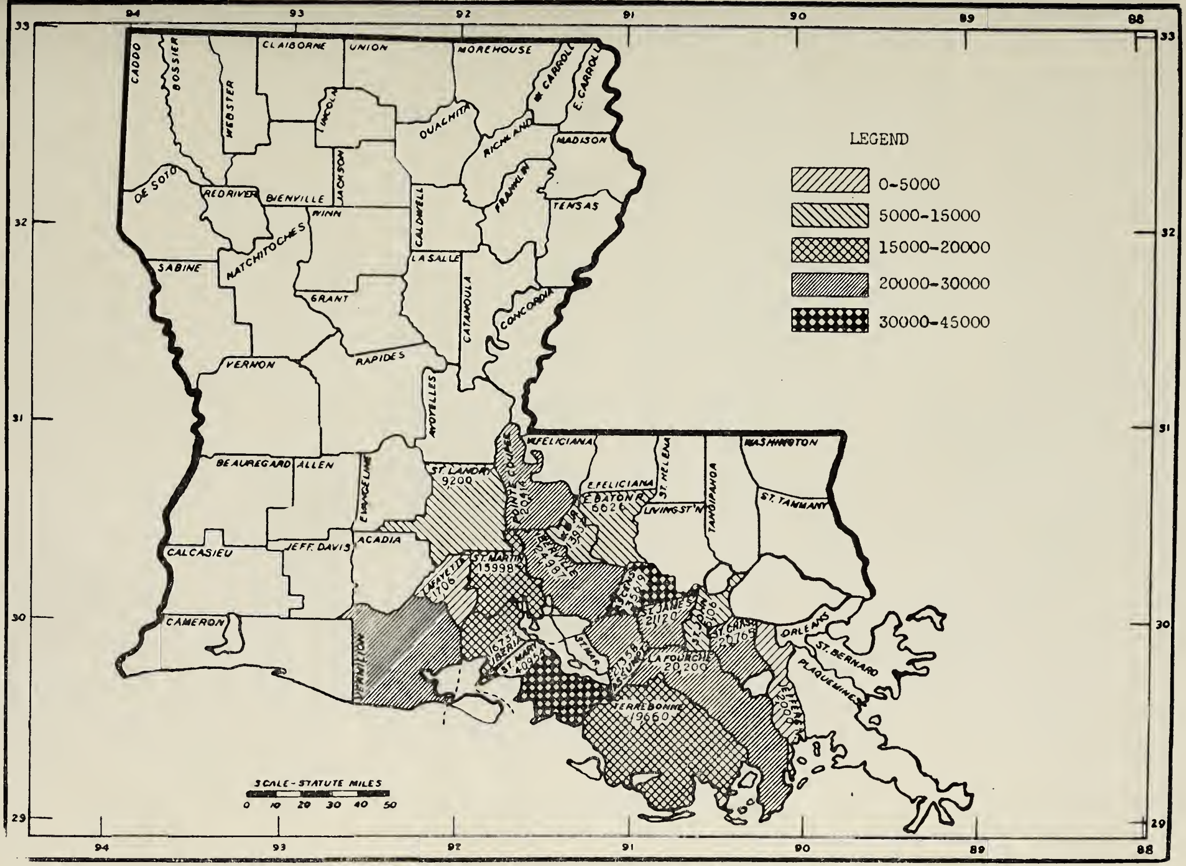

FIGURE 2. THE LOCATION OF IDLE CULTIVATABLE LAND IN THE SUGAR CANE AREA OF LOUISIANA

In the border parishes, or minor area, the comparable figure was 194,587 acres. Since the census enumerated only 64 per cent as much idle cultivable land as was found in the survey in 1934, it appears that the cause of departure of the census data was probably present in earlier years as well as at the present time. No recognition has been given to the new land that has been brought into farms. While the total land in farms has declined for the major area, it is probable that some new lands were opened and other lands went out of farming. There is reason to believe that some new owners or operators would start on new land rather than on land that was encumbered with debt, or corporately held. If this is true, then the enumeration of the new land brought into cultivation would be more complete than for land that became idle and unoccupied. Thus, it appears that becoming idle would add to the possibilities of its escaping census enumeration.

The extent to which different crops contributed to this decline in cultivatable land is confused because of the possibility of shifting acreages from one crop to another. For the same relative census dates the four most important crops of the major area (corn, sugar cane, cotton, rice) showed a combined decline from their highest to their lowest acreage of 96,000. In the border area the comparable figure was 111,000 acres. It is quite likely that the highest or lowest acreages were not reached in any census year. Likewise, the data do not tell us whether the same land area was involved throughout the period or whether new land was taken into cultivation while land in cultivation became idle. The net change indicated for these crops should not be considered the amount of abandonment that resulted from competitive forces, as acreage adjustment was in operation in 1933 and 1934. Here again it is not possible to tell just how much of the land released under the crop adjustment program was planted to other crops.

The census data are quite inadequate to show the full extent of the change though it does give some indication of the trend, and the probable lower limit. The data obtained in the survey answer more completely the questions under consideration.

The extent to which the present idle cultivatable land was used for the different crops may be arrived at from a classification of the data on the basis of the last previous crop on the land. Our study showed that sugar cane was the previous crop on 49 per cent of the idle land in 1934. Rice last occupied 15 per cent, and cotton 1.2 per cent. About two per cent of the idle land had been prepared for crop use but was never planted.

A very wide variation in the previous use of idle land existed between size groups. Relatively the highest proportion of the cotton acreage was on small tracts, and the lowest on the large plantations. The rice acreage was relatively greatest on the medium tracts of 100 to 999 acres in size. The sugar cane acreage varied greatly with the small tracts having 30 per cent of their idle land last in sugar cane, the medium sized tracts showed 40 per cent, and the large plantations 58 per cent. The proportion of the cultivatable acreage in sugar cane for tracts with no idle land in 1934, was 31, 41, and 63 per cent for the respective size groups. A remarkably close association exists. Clearly, the previous use of the present idle land for sugar cane production is not greatly different from the comparable present use of land in cultivation. Just what proportion each crop should occupy of the total cultivated land as idle land is returned to use, depends as much upon costs and returns as upon historical record. The adjustment must be in terms of present and prospective conditions rather than past relationships.

Of considerable interest, also, is the period in which the land became idle. While land may have been idle at different times it is reported in this study from the time it became idle last and remained so until 1934. The data are for all tracts on which regular schedules were obtained. Since they included about 98 per cent of the total idle land there is little likelihood that the omission would influence the results obtained.

Six divisions have been used in determining the period in which the land became idle. These are as follows: Prior to 1915, 1915-1919, 1920-1924, 1925-1929, 1930-1934, and unclassified. It was necessary to group as unclassified a number of tracts for which the exact information was not available. The land so classified was 14.0 per cent of the total and was relatively greater on the small tracts than on the large ones. The per cent of the idle land for tracts of different sizes is shown in Table 5, for the year that the tracts became idle. The period in which the greatest acreage became idle was from 1925-1929, during which 40.1 per cent of the present idle acreage passed out of cultivation. It was during this period that the ravages of mosaic disease and the sugar cane borer reached their peak. The disastrous flood of 1927 caused a heavy decline in acreage that year, some of which never returned to production. The next most important period from the standpoint of acreage becoming idle was for the five years, 1930-1934, during which 19.3 per cent of the acreage was lost to cultivation. Probably the effects of declining prices and lack of operating credit were the most important difficulties in this period.

Of the three remaining periods the immediate post-war period was most severe. It contributed 12.4 per cent of the total idle land in 1934; the war period 1915-1919 contributed 8.8 per cent; whereas the total for the period prior to 1915 was only 5.3 per cent.

The present idle cultivatable land has come into existence largely since 1914, with slightly more than 70 per cent of it during the period since the close of the World War. We have treated the data so far as averages for all groups and both idle and partly idle land-use classes. Some important differences should be pointed out for these classifications.

Of the tracts that were fully idle those of medium size dominated the acreage in all periods except 1915-1919, when the plantations of 1,000 acres or more furnished 56 per cent of the total cultivatable land that became idle. The large tracts were relatively the smallest contributors to idle land in the period, 1930-1934. The small tracts in this land-use class contributed most heavily in the pre-war period, with 14.3 per cent, and were lowest in the two subsequent five-year periods, only to increase sharply between 1925 and 1934.

A somewhat different picture is found for the tracts that had only a part of their land idle in 1934. The small tracts were relatively less important and the large tracts more important in their contribution to the total idle land than for the fully idle land-use class. The present idle land on these partly operated tracts was contributed in each period largely by tracts of 1,000 acres or over, except for the period prior to 1915 when the medium size was dominant. Small tracts were relatively small contributors of idle acreage in all periods. Probably the small tracts that went out of production during the past had regained their loss mostly before 1934 to a degree not found on the larger plantations or had lost their identity through sale and annexation with larger tracts.

In addition to the acreage of land that became idle during different periods, another factor which is controversial and on which our data throw some light, is the average size of the idle tracts. For tracts that became idle and remained so until 1934, the variation in size for different periods may reflect a result of the forces causing idleness. For the tracts that have only part of the cultivatable land idle,

TABLE 5. PER CENT OF IDLE CULTIVATABLE LAND FOR TRACTS OF DIFFERENT SIZE, ACCORDING TO THE YEAR THE LAND BECAME IDLE, 1934

Year the land became idle	Tracts with all of cultivatable land idle				Tracts with part of cultivatable land idle			
	Under 100 acres	*100 to 999 acres*	*1,000 acres and over*	*All tracts*	*Under 100 acres*	*100 to 999 acres*	*1,000 acres and over*	*All tracts*
Prior to 1915	8.8	6.5	6.7	6.8	4.4	8.5	3.0	4.9
1915-1919	6.6	8.3	19.8	12.0	6.6	7.9	8.3	8.0
1920-1924	10.9	14.4	13.2	13.6	12.3	17.1	9.3	12.1
1925-1929	39.0	32.6	42.2	36.5	26.9	34.4	46.3	41.1
1930-1934	19.1	21.3	11.1	17.6	23.4	20.1	19.1	19.7
Unclassified	15.6	16.9	7.0	13.5	26.4	12.0	14.0	14.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

comparison encounters some difficulty, because the expansion in acreage cultivated in recent years has been largely on idle land we presume, and, therefore, gives an average acreage of idle land at the present time on the basis of the period in which it became idle. Hence the data are not entirely comparable between land-use classes; however, it is probable that no serious discrepancy exists.

The average acreage of idle land was relatively high in the pre-war period, during the war, and during the period in which the peak of mosaic disease, cane borer, and flood damage occurred. This is greatly influenced by the number of large tracts that became idle in these periods as well as the economic obstacles that could not be overcome.

Precisely the same tendency is shown for the present idle land on tracts that are partly operated. It appears, therefore, that adverse conditions changed the level of profitable production and forced land into idleness. It exerted adverse effects upon all tracts, but to a greater extent upon those of comparatively large size. This, however, is typical of other types of farming in Louisiana.

PRESENT SUGAR CANE ACREAGE

The analysis of cultivatable land may be carried further into the use of the idle and tilled land in 1934. The idle cultivatable land was grazed, mowed, or entirely abandoned. A number of operators have developed dairying and beef cattle production. Others were using the idle land for hay and seed production. Several persons interviewed did not desire to return the cultivatable land to tillage because they had developed other uses for it and had adjusted their organization to these new uses. The number of tracts so situated, however, was a comparatively small part of the total.

The land in cultivation was devoted largely to sugar cane, corn and soybeans, rice, truck crops, and cotton. All of these crops had been grown on part of the land that was idle in 1934. Since the previous crop use of the idle land has been presented, our attention will now be directed toward the present position of sugar cane on the land in cultivation.

The acreage in cane for the tracts of land included in this survey was 206,601. The measured acreage in the spring of 1935 for an approximately comparable area (the total area less the area for parishes not included in the survey) was 202,346.[4] The difference between these two estimates is comparatively small. Part of this difference may be accounted for because the survey included some tracts which were not under contract and thus escaped measurement.

A division of the sugar cane acreage between land-use classes shows 47 per cent in the fully operated tracts and 53 per cent in those partly operated. Not all of the tracts in either class had sugar cane. Of the tracts fully operated, 77 per cent reported sugar cane in 1934. This is slightly higher than was found for the partly operated tracts, 70 per cent.

While no great variation prevailed in the proportion of tracts not growing cane in the different land-use classes, some very marked differences are found between size groups in each land-use class. As the average size of tract increased, the proportion of tracts with sugar cane increased. For example, on tracts now fully operated, 53 per cent of the tracts obtained by sample schedules, 88 per cent of the small tracts, 92 per cent of the medium sized tracts, and 97 per cent of the large tracts had cane. While the partly idle tracts showed a lower proportion of the farms in all size groups with sugar cane, precisely the same relationship prevailed between size groups.

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[4] From information furnished the writers by M. J. Voorhies, Senior Agricultural Economist, Sugar Section, Agricultural Adjustment Administration.

The small tracts have not gone into sugar cane to the extent that larger tracts have. Many of them are producing truck crops or do not care to return to sugar cane production. However, there is reason to believe that many small operators will return a part of their present cultivated acreage or idle land to sugar cane if conditions permit. It has been pointed out that the small tracts are dominantly in the fully operated land-use class. The relatively small acreage of sugar cane per tract for each size group in the partly idle land-use class is only an indication of the stage of return reached at this time. For each size group the average acreage of sugar cane in partly operated tracts compared with fully operated tracts was about 30 to 50 per cent lower. Since all size groups of the partly operated tracts are low in the proportion of their cultivatable land in cane, it is fairly convincing that the intentions of many operators is to increase their farming operations, including the expansion of sugar cane. Much of this has been under way for several years. Apparently, it is not conditioned upon any new development in program planning. It is essential, therefore, to go further into the plans of all operators to ascertain the nature of the intended expansion.

PROPORTION OF PLANT CANE

So far we have dealt with sugar cane arceage as a unit. In practice, however, there is considerable distinction to be made between plant and stubble cane with respect to yields and costs. The chief question to be answered in analyzing the proportion of the total sugar cane acreage in plant cane was the degree to which land-use classes and size groups were expanding sugar cane production through the possible introduction of new varieties and bringing new land into cultivation. A relatively high proportion of the acreage in plant cane should indicate the abandonment of old stubbles in favor of plant cane of the same or newer variety and probably higher rates of production. It might mean the expansion of cane acreage by new planting. These conditions may be explained further.

For all tracts covered by regular schedules, plant cane comprised 50.9 per cent of the total sugar cane acreage. The fully operated tracts had 52.7 per cent of the total cane in plant cane and 49.5 for the partly operated tracts. While at first it may be expected that the partly operated tracts should have the higher per cent, it is probable that the fully operated tracts are so because they have already exhausted their idle land supply through increased sugar cane and associated crops.

A very interesting variation is found between size groups as well as land-use classes. The small tracts have a much higher proportion of their sugar cane acreage in plant cane than have large tracts. The comparative figures for all tracts were 59.4 and 46.5 per cent, respectively. Little difference in the relative proportion of plant cane for size groups prevailed for the tracts that were fully tilled compared with those only partly tilled.

The fact that small tracts had a higher proportion of plant cane than large tracts may be due to several conditions. The smaller tracts shift to plant cane as their stubble deteriorates. Since the smaller operators tend, on an average, to adopt new practices more slowly than the larger operators, it is possible that they have not introduced the newer varieties as rapidly as the larger holders and, as a result, are not obtaining as high yields from the stubble. This would be an inducement to keep the proportion of plant cane relatively high. It is also probable that many of these small growers are emerging from other lines of production in order to get into cane production. A more comprehensive discussion of this point will be presented later.[5] The large plantations have a more serious peak labor problem than the small operator so that a longer harvesting season is a necessary part of good organization. Since operators of the larger tracts are quick to adopt new varieties it is probably true that the need to shift from stubble to plant cane because of low stubble yield has disappeared somewhat. The comparative yield will throw additional light on this point.

The discussion of present sugar cane acreage indicates the tendency to increase and ascertain resources favorable for such an increase. In so far as present operators are able to project plans, let us see to what extent they desire to expand sugar cane acreage.

SUGAR CANE YIELD PER ACRE AND PRODUCTION

There has been a very marked change in the yield per acre of sugar cane in Louisiana since the advent of the mosaic disease. In 1926 the yield per acre reached a low point for the past two decades of 6.8 tons. While the acreage of cane used for sugar was lower in 1927, due to the flood of that year, the yield per acre was practically double that of 1926, and has maintained a level since 1927 of about 16 tons per acre.[6] During this period the acreage of cane used for sugar was increased from 72,000 in 1927 to 239,000 in 1935. Obviously, such a change is not typical of the trends of most agricultural products during a similar period. Marked technical and economic recovery has been achieved in the face of adverse economic conditions, debt incumbrances, credit shortages, and trade disturbances.

In 1934 the average yield of sugar cane per acre for all purposes on 3,668 of the tracts studied was estimated at 12.3 tons. It is derived from all of the tracts for which regular schedules were obtained and covered approximately 98 per cent of the land area in cane. This estimate differs somewhat from that reported by the Agricultural Statistician, as it includes all cane for all purposes rather than sugar cane for sugar. Furthermore, the average reported here is the average of a group of simple average yields and gives weight to individual averages rather than acreages. Since the yield for small tracts is much less than for medium- and large-sized tracts, and about 60 per cent of the tracts were small tracts, it is true that the weighting used has had the effect of giving a low yield.

For the same crop year the Agricultural Statistician reported the average yield of cane for sugar at 13.6 tons, and for all purposes, 13.3.[7] Had the yields for the survey data been weighted by the corresponding acreage of cane in each size group, the average would have been 13.0 tons per acre. The difference between these two estimates may be attributed partly to the methods of obtaining the estimates and the area actually included as land in cane.

A comparison with yield per acre reported by the census for the same year may be made. Computations from acreage and production figures show an aggregate average yield per acre of 12.5 tons. This compares with the average for this study of 12.3 tons, and for the Agricultural Statistician of 13.3 tons. Yield per acre as obtained in this study seems to be in close agreement with those of other agencies. If this be true, then the variations arising from the breakdown into the various land-use classes and size groups should provide a fairly accurate comparison on rates of production.

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[5] See page 30.

[6] United States Department of Agriculture, Yearbook of Agriculture 1931, Table 165, page 671; and Yearbook of Agriculture 1935, Table 143, page 442.

[7] Lionel L. Janes, United States Department of Agriculture, Bureau of Agricultural Economics, Louisiana Sugar Syrup and Molasses Report, July 8, 1936.

The average yield per acre was 12.0, 12.8, and 13.3 tons for the small, medium, and large tracts, respectively. This indicates one important difficulty experienced by small operators in competitive production. Also, it indicates another important characteristic with respect to size; namely, that a high yield may be necessary in order to operate a large size of business, or permit it to stay in business under adverse conditions.

The tracts with no idle land had a much wider spread in the average yield for different size groups than did tracts with idle land. The small tracts reported 11.8, compared with 15.3 for the large tracts. It is possible that this high yield for large tracts accounts for their full operation at the present time. Any appreciably lower yield would have made operations so unprofitable as to force idleness.[8] This may be indicated further under estimates of normal yield. In a like manner, it may be pointed out that the very low average yield on the small tracts makes it advisable for them to keep their sugar cane acreage low. Many of these small tracts are in the border area between sugar cane and other cash crops. Also, competitive uses of the land for such activities as beef cattle production, dairying, part-time farming, and industrial sites, are not to be overlooked.

There was a marked contrast between average yields for tracts with no idle land and those with part of the cultivatable land idle. The average for all tracts in the former group was 12.2 tons per acre, compared with 12.5 in the latter group. The small tracts, however, estimated their average yield at about the same rate as did the operators of the larger tracts, 12.3, 12.7, and 12.9, respectively for the three size groups. This may be due in part to the higher proportion of plant cane on the smaller tracts, to the more recent opening of new land, and to production problems encountered by the larger units in maintaining high yields on the tracts now partly idle, as well as is done on fully operated tracts. Acreage and yield per acre of cane are conditioning factors in the continuous operation of sugar cane farms. If adverse conditions are encountered, relatively higher yields must be maintained on larger units for survival; likewise, under favorable conditions large size may be economically possible with low yields. Reuss has shown that farms with a current yield twenty per cent above the average obtained in 1930, a net cash income per crop acre of $8.24 compared with $0.81 for farms with a yield of 20 per cent or more below average.[9]

The use of current yield per acre has one serious objection. In any given year conditions may be such for an area as a whole, or districts within the area, that current yield may depart greatly from the usual. In order to make some test of this variation for 1934, estimates of normal yield were obtained. No historical series of yield were available for determining the soundness of the current yield estimates or the indicated normals. It was expected that the estimates of normal would be above the current yield.[10] In fact, all size groups in each land-use class placed the normal above the present yield. The tracts that were fully operated placed their normal yield at 14.0 tons per acre compared with an actual yield of 12.2. The tracts with part of the land idle had 15.5, and 12.5 tons, for the respective estimates. Idle tracts estimated a normal of 18.3 tons. Incidentally, these normal yields are not greatly different from the average yield for a period of years, 1928-1934.[11]

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[8] Factories are frequently operated in connection with large plantations and profits from the factory may be used to keep the plantations in business longer than would be possible otherwise.

[9] Reuss, G. H. The Organization and Financial Returns of 129 Small-Sized Louisiana Cane Farms. 1930. Louisiana Bulletin Number 224, July 1931, Table XVII, page 36.

[10] Callander, W. F., and Becker, Joseph A. The Use of "Pars" and "Normal" in Forecasting Crop Production. Journal of Farm Economics, Volume V, Number IV, page 187.

Operators of small tracts reported the lowest normal yield, and the largest tracts the highest normal. The least spread between actual and normal was found for small tracts that have no idle land. Though the partly operated tracts have higher current yield than fully operated tracts, the estimates of normal were relatively greater than for fully operated tracts. The normal exceeded the actual by 15 per cent on tracts with no idle land compared with 24 per cent on partly operated tracts. This difference between normal and actual may be partly due to an overstatement of the normal. The normals, however, are within the limits of conducted experiments.[12] On the basis of actual and normal yield per acre there is indication that the rate of production on tracts idle or partly idle is higher than prevails on fully operated tracts. This should be of considerable significance in the restoration of the land to agricultural use.

Attention so far has been given to the rate of production per acre. With this background we may proceed to total production for land-use classes, and size groups, on present acreage and future possibilities under the desired use of land.

The total tonnage of sugar cane on the tracts included in this survey was 2,658,186. This may be compared with the 1934 census enumeration for the same parishes of 2,619,867 tons, a difference of less than two per cent. The production in 1934 was about equally divided between tracts that were fully operated and those partly operated, 47.5 per cent for the former, and 52.5 per cent for the latter. Fifty-two per cent of this production was on large tracts, 34 per cent on medium-sized tracts, and 14 per cent on small tracts. On the tracts with no idle cultivatable land the relative proportion of the production on the small tracts was above average, being 23 per cent compared with six per cent for a similar size group with part of the cultivatable land idle.

It is of further concern to the area to know what changes would be made in the distribution of sugar cane production for the land-use classes and size groups, if the desired acreage were to become a reality. Production has been determined for this purpose from 1934 actual average yields and the desired acreage except for those tracts that were idle in 1934. For this class the average yield for the corresponding size group of tracts growing sugar cane was used.

The production of sugar cane, if the desired acreage were operated, and present (1934) average yields obtained, would be 5,250,354 tons, an increase over the present production of 97.5 per cent.[13] This production would be distributed most heavily to the tracts partly cultivated. The per cent of the total production accruing to each land-use class would be 32.2, 7.0, and 60.8, for the tracts with no idle land, all idle land, and partly idle land, respectively.

Only minor shifting is indicated for the size groups within each land-use class. For example, on the tracts with no idle land the small tracts would gain in proportion of total production from 23 to 28 per cent. A similar loss is indicated for the large tracts. For those tracts with only part of the cultivatable land in use the significant change is a relative gain for tracts of medium size and a relative loss for the large tracts. The small tracts of similar land-use classification would retain approximately the same relative proportion of production under the desired acreage as they have at present.

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[11] See page 21.

[12] Gouaux, C. B. and Simon, E. C. Sugar Cane Variety Report, 1933. Louisiana Agricultural Experiment Station Bulletin Number 247, April, 1934.

Gouaux, C. B. and Simon, E. C. Sugar Cane Variety Report, Season of 1935, Louisiana Agricultural Experiment Station Bulletin Number 274, June, 1936.

O'Neal, A. M. and Breaux, S. J. Jr. Soil Fertility Investigations, Sugar Cane District of Louisiana. Louisiana Agricultural Experiment Station Bulletin Number 222, June, 1931.

[13] The total is computed from individual size groups.

This analysis of yield per acre and actual and prospective production of sugar cane indicates that small tracts have a lower rate of production both actual and normal, and that they would gain slightly in relative volume of output under the desired acreage. The large tracts have the highest actual and normal yield per acre. They would lose slightly in the relative share of total output under the desired cane acreage at present rates of production.

DESIRED SUGAR CANE ACREAGE

Many attempts have been made by individuals to construct a picture of the use of the resources of the area. The method used in this study in arriving at such a picture was through individual operator's intentions of restoring sugar cane production. Each person interviewed indicated the possible cane acreage and the desired acreage on the tract under consideration. Such estimating may be highly subjective. At least it should not be misconstrued to mean that it would be economically feasible. The idea was to bring the opinions into concrete form, so that they might be compared with actual accomplishments. Results obtained by this method would represent a range of experiences far more convincing than that of only a few people. The estimates dilineate rather definitely requirements for the use of existing land resources under the present status of experiences.

The degree to which each individual, in being called upon to estimate the desired use of the cultivatable land, is biased by recent tendencies is questionable. Certainly the problem of quotas and acreage limitations, together with the rapid business recovery in 1933 and 1934, includes a strong personal bias in favor of an expansion of sugar cane. It is unfortunate that this study was not made before these complicating factors became present. An examination of these opinions and the application of certain tests will be quite explanatory. Certainly farmers used care in estimating because, in many instances, the possible cane acreage exceeded the desired acreage or no cane acreage was desired. These farmers have developed satisfactory systems already or do not want to assume the responsibilities of sugar cane production.

REASONABLENESS OF DESIRED ACREAGE ESTIMATES

In agronomic experiments it is usually the technique to compare results of the variable practices with that of a check plot. A somewhat similar test may be used in this study. Since some of the operators of tracts with no idle land have ample cane acreage at the present time, we have a check group from which to test the reliability of estimates for those tracts not fully operated or on which more intensive operation is desired. This assumes that all of the land and human resources possess possibilities equal to those of the check group drawn from the fully operated tracts. This is not always true. It is reasonable to believe that estimates for undeveloped tracts might well be measured against actual accomplishments of fully operated tracts, if a fairly large number are included.

Not all of the fully operated tracts had the proportion of their acreage to sugar cane that they desired. This comes about because the return of once idle land to sugar cane production is slow and requires tillage and cropping preparation of the land and the restoration of working capital. It should be kept in mind that the sugar cane acreage in Louisiana declined from 310,000 acres in 1911 to 72,000 in 1927, and had recovered again to 197,000 acres by 1934.[14] The ability to recover was largely due to technological improvements in production practices which went ahead even in the face of adverse economic conditions. Therefore, it is quite possible that the approach used here for testing these anticipated developments is not seriously in error for the purpose of arriving at a possible use of the land. The reader is cautioned not to assume that anticipation is considered commensurate with privileges or rights. No such aim is intended.

The desired sugar cane acreage, as shown by the reports obtained, was 404,789 acres, an increase of 95.9 per cent over that for 1934 (206,601). While this increase would approximately double the acreage of 1934, its intended distribution among land-use classes and size groups may be helpful in future planning for the area. Unless there is to be a rather wide immediate diffusion among families of the acreage to be returned to production, a program of adjustment loses much of its humanitarian significance.

The new acreage of sugar cane, that amount by which desired acreage exceeds present accomplishments, is largely on tracts that were partly idle in 1934. For the three land-use classes, no idle, all idle, and partly idle land, the proportion of the increased acreage was 16, 14, and 70 per cent, respectively. Within each land-use class the operators of large tracts indicated the smallest relative increase and the operators of medium tracts, the largest increase due primarily to the change in the idle land. On tracts with no idle land the increase desired by operators of small tracts was much greater relatively than for the medium and large tracts. Comparative data for actual and desired sugar cane acreage by land-use classes and size groups are given in Table 6.

The interest in the relationship of present acreage to desired acreage has been very great in the various parishes. In order to show this detail the data are segregated by parishes (Table 7). The largest acreage increase is in St. Mary's Parish, which is the most typical plantation parish of the area. Other parishes with a high increase are Iberia, Assumption, St. Martin, Terrebonne, Iberville, Ascension, and Lafourche, with increases of about 15,000 acres or over. The greatest relative increases were in St. Charles, Ascension, St. James, St. Mary, Vermilion, and St. Martin Parishes where the desired increase exceeded the actual acreage reported in 1934.

To what extent are these changes indicated by land owners and operators attainable? This may be tested, in part at least, by the use of technical relationships. Such tests would be expected to show a fairly definite conformity to the average for all land-use classes, because the actual experience of present operators is our best guide with which to measure anticipated accomplishments of other operators. This may be carried even farther through the use of the check group. This check, as was previously stated, includes the fully operated tracts on which no expansion or even a reduction in sugar cane acreage would be desired. When making comparisons of size of tract and present land use, it is reasonable to expect that the desired goal in future land use and in efficiency would conform closely to actual present accomplishments. The data support this conclusion.

PROPORTION OF CULTIVATABLE LAND IN CANE

The proportion of land in cane tends to vary with the size of the tract. Usually small tracts have a much lower proportion of their cultivatable land in cane than do

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[14] United States Department of Agriculture, Yearbook 1923, Table 357, page 844, and Yearbook 1935, Table 143, page 442.

Table 6. Present and Desired Sugar Cane Acreage in Idle, Partly Idle, and Fully Cultivated Tracts, According to Size of Tracts, 1934

Size of tract	*Tracts with no idle cultivatable land*			*Tracts with no land in cultivation*		
	Present acres	*Desired acres*	*Per cent change*	*Present acres*	*Desired acres*	*Per cent change*
Small	25,469	40,512	+59.1	....	3,291	....
Medium	37,791	51,079	+35.2	....	15,415	....
Large	32,977	35,417	+ 7.4	....	9,617	....
TOTAL	96,237	126,998	+32.0	....	28,323	....

Size of tracts	*Tracts with part of cultivatable land idle*			*All tracts*		
	Present acres	*Desired acres*	*Per cent change*	*Present acres*	*Desired acres*	*Per cent change*
Small	7,410	19,125	+158.1	32,879	62,928	+ 91.4
Medium	32,170	82,961	+157.9	69,961	149,445	+113.6
Large	70,784	147,382	+108.2	103,761	192,416	+ 85.4
TOTAL	110,364	249,468	+116.0	206,601	404,789	+ 95.9

Table 7. Actual and Per Cent Change in Desired Sugar Cane Over Present Acreage, by Parishes, 1934

Parish	*Sugar cane acreage*		*Desired change*	
	1934	*Desired*	*Acreage*	*Per cent*
Ascension	6,847	21,403	14,556	212.6
Assumption	25,120	43,604	18,494	73.6
Iberia	33,320	54,853	21,533	64.6
Iberville	20,826	36,268	15,442	74.1
Lafourche	23,671	38,332	14,661	61.9
St. Charles	1,907	13,482	11,575	607.0
St. James	9,331	23,501	14,170	151.9
St. John	8,818	13,824	5,006	56.8
St. Martin	15,180	32,972	17,792	117.2
St. Mary	24,795	56,937	32,142	129.6
Terrebonne	19,851	35,372	15,521	78.2
Vermilion	5,408	11,805	6,397	118.2
West Baton Rouge	11,527	22,426	10,899	94.6
TOTAL	206,601	404,789	198,188	95.9

large tracts. This is a characteristic of the economy of the area as shown in farm management studies of small- and medium-sized farms by Reuss.[15] If sugar cane expansion on the idle land were to go no further than the corresponding proportions that existed on the land in cultivation in 1934, it would account for more than half of the desired increase in cane. It is obvious from the data, Table 8, that the desired acreages for tracts that are idle or partly so are uniformly below those of the tracts with no idle land and are not out of proportion for good farming practices as shown by Reuss.[16]

Have the tracts that were fully operated overestimated their proportion of cultivatable land in sugar cane? Very little increase is shown for the large-sized tracts. Tracts of small or medium size have included more truck crops in their organization than was true of the large tracts and have balanced operations in that way together with lower current cash outlays. The present low proportion of sugar cane to total cultivatable land may be accounted for by the slow return of these tracts to normal operations. That there is some weight to be given to the estimates obtained in this study is substantiated by a previous study by Reuss of small farms indicating the

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[15] Reuss, G. H. An Economic Study of Factors Affecting Farm Organization and Power Utilization of Sugar Cane Farms, 1929, Louisiana Bulletin Number 215, Table 1, page 25, November, 1930.

Reuss, *op. cit.*, Table V, page 14.

[16] *Ibid.*, page 26. "Maintaining as large a proportion of the crop land as possible in cane, the cash crop is essential in obtaining a satisfactory income. Income increased directly with the amount of cane up to the point of approximately 50 per cent of the crop area in cane. Net income decreased on farms having more than this proportion of cane, due principally to a rapid rise in feed and labor expense which accompanied high cane acreages. This percentage figure cannot be set definitely for it is influenced by the yield of feed crops, fertilization practice, soil improving crops used, price of feed, and by the amount of second stubble kept. Farms with a low proportion of cane (39% or less) definitely made lower incomes than did those falling in the range of 40 to 60 per cent."

Table 8. Proportion of Tracts with Sugar Cane in 1934, Per Cent of Cultivatable Land in Sugar Cane Compared with the Proportion Desiring to Grow Sugar Cane and the Per Cent of Cultivatable Land in Sugar Cane for the Different Land-Use Classes, According to Size of Tract, 1934

Size of tract	*Tracts with no idle cultivatable land*				*Tracts with no land in cultivation*			
	Per cent growing cane	*Per cent of cultivatable land in cane*	*Per cent desiring to grow cane*	*Per cent of cultivatable land in cane*	*Per cent growing cane*	*Per cent of cultivatable land in cane*	*Per cent desiring to grow cane*	*Per cent of cultivatable land in cane*
Small	73	31	89	50	..	..	63	39
Medium	92	41	96	56	..	..	84	54
Large	97	63	100	67	..	..	71	56
TOTAL	77	43	90	56	..	..	68	52

Size of tracts	*Tracts with part of cultivatable land idle*				*All tracts*			
	Per cent growing cane	*Per cent of cultivatable land in cane*	*Per cent desiring to grow cane*	*Per cent of cultivatable land in cane*	*Per cent growing cane*	*Per cent of cultivatable land in cane*	*Per cent desiring to grow cane*	*Per cent of cultivatable land in cane*
Small	61	16	83	42	64	24	85	47
Medium	81	20	94	51	79	25	94	53
Large	90	27	96	57	83	31	95	58
TOTAL	70	24	88	53	68	28	88	54

difficulty experienced with truck crops and the proportion of sugar cane which gave optimum net returns.[17]

Further comparison may be made for fully operated tracts on which the operator had no desire to increase the sugar cane acreage. The cane acreage on these selected tracts in 1934 was 57 per cent of the land in cultivation compared with a desired cane acreage for all small, fully operated tracts, of 50 per cent. This is ten per cent more than the average for all tracts of small size. No appreciable difference appears for the larger size of tract groups. The tracts of medium size, and desiring no increase in sugar cane over their 1934 acreage, had 61 per cent of their cultivatable land in cane. This average performance is, likewise, above any of the group averages for desired acreage. On the large plantations that were fully operated, and did not desire to increase the acreage of sugar cane, the proportion of cultivatable land in sugar cane was 68 per cent. This compares with the desired proportion of 67 per cent for all fully operated tracts, 56 per cent for idle tracts, 57 per cent for the partly idle tracts, and 58 per cent for all tracts. All of these estimates made are, on the average, below the actual accomplishments of operators on fully operated tracts where sugar cane was grown in 1934 and on which no increase in sugar cane acreage was desired. Since some of the operators indicated their desire to reduce the acreage in sugar cane, it appears fairly certain that part of them have gone too far in the proportion of sugar cane to total cultivatable land. For this test of the desired use of the cultivatable land for sugar cane production there seems to be little evidence that the case has been overstated. However, other tests may be examined.

Acres of Cultivatable Land Per Tract

The proportion of the land area in sugar cane does not describe the land-use picture adequately if there are marked variations in the average land area per tract between the size groups or land-use classes. A further test of the desired cane acreage may be made from a comparison of the cultivatable land area per farm available in each land-use class for similar size groups. Small tracts with no idle land had an average of 27 acres of cultivatable land per tract, compared with 33.5 acres for the partly idle group, and 22 for the idle group. The average for small tracts with sugar cane in 1934 and desiring no increase was 37.7 acres. This would indicate that a lower proportion of the land in sugar cane for all tracts would be expected than was found for the test group. A higher proportion existed for partly idle tracts; a lower proportion prevailed for the other land-use classes.

The acreage of cultivatable land for the medium-sized group (tracts 100-999 acres) was 136 for the fully used group, 183 for the partly operated group, and 215 for the idle group. It would be expected that more substantial increases in desired acreage and efficiency in the use of human labor and work stock would be attained on the partly or wholly idle tracts. A wide variation in average size exists. Medium-sized tracts that had no idle land and on which no increase in their present cane acreage was desired had an average of 169 acres. If size were correctly reflected in the proportion of cultivatable land in sugar cane, it would follow that the proportion on idle and partly idle tracts would be above that of the test group. Actually, they were considerably lower.

The large-sized group showed a very wide variation in the acreage per tract between land-use classes. Those tracts that were fully operated had 1,420 acres of cultivatable land, on the average; the partly operated tracts, 1,403; and the idle tracts only 817. The large tracts that had sugar cane in 1934 and desired no further expansion were comparatively small, 984 acres. Here again, the average proportion in sugar cane for each land-use class, except the class with all of the land idle, should be higher than for tracts desiring no increase. This, however, was not the case.

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[17] *Ibid.*, Table XI, page 24, and Chart 3, page 28.

These comparisons of relative sizes indicate that tracts now partly or entirely idle have, on the average, adequate cultivatable land area to accomplish what is already being accomplished on tracts with no idle land. While their present acreage in cultivation per tract is relatively low, the extra acreage of idle cultivatable land would make a total cultivatable acreage in excess of that prevailing on tracts with no idle land. Two noticeable departures from this generalization appear in the case of small tracts and the large plantations now idle. If proportion of cultivatable land in sugar cane increased with size, it would be expected that the desired acreage in these tracts would exceed that of fully operated tracts. It has just been shown that such was not the case.

INTENTIONS FOR 1935 COMPARED WITH 1934

Some generalizations on the immediate trend in acreage of sugar cane for the persons interviewed may be made from the data obtained. While its completeness is partly questionable due to a strong bias that had developed in the area at about the time this survey was in progress, it is indicative of the trend by land-use classes and size groups. The bias is believed to be in favor of the tracts that were fully operated, since these operators would tend to underestimate the increase in acreage rather than the decrease, so that conformity with rental contracts would be unchallenged. The persons interviewed were questioned with respect to the acreage of cane for 1935 compared with 1934, and the change recorded. The extent to which quota limitations and unfavorable organization and management practices prevailed would be reflected partly in the changes made in the sugar cane acreage. An examination of the reported changes offers further explanation of the reliability of the estimates for desired acreage.

The Agricultural Statistician, in a report of July 15, 1936, estimated the sugar cane acreage in 1935 at an increase of 11,000 acres over 1934 in the 22 sugar cane growing parishes. Our study of a more limited area did not reveal such a large increase. The net increase on 2,411 tracts, out of a total of 4,747 was only 1,150 acres. Several factors seem to have been important in accounting for this discrepancy. The entrance of a large number of new producers, particularly from the border areas and the truck growing area, was a factor.[18] Also, there were some large producers who expanded their acreages and could not qualify under the adjustment program. There would be a tendency for growers to report the acreage planted or expanded acreage low so that they would meet contract requirements. It was felt, however, that some significance may be attached to the relative position indicated by the data obtained.

For all tracts with no idle cultivatable land, the acreage change was *a net decrease* in the acreage for 1935 over 1934. About half of the tracts in this land-use class reported a change for 1935, with over 90 per cent of the net decrease found on tracts of 100 acres and over. Probably quotas could be filled easily, with the better yielding varieties of sugar cane, by reducing acreage somewhat. On the partly cultivated tracts *a net increase* was reported for each size group. Again, about one half of the tracts reported a change, with 70 per cent of the net change being on tracts of 100 acres or over. About six per cent of the tracts that were idle in 1934 were planted in cane in 1935. Of these over 80 per cent of the increase in acreage was on tracts of less than 100 acres.

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[18] From information furnished the writers by the Sugar Section, Agricultural Adjustment Administration.

This use of data to indicate the direction of change is helpful in visualizing the immediate change that is taking place. In getting estimates of changes and reason for them it was quite common to find insufficiency and uncertainty about quotas as a factor. Others mentioned included lack of credit, more favorable uses of land, other systems of farming desirable, labor shortage, poor stubble.

WORK STOCK EFFICIENCY

Another test that is quite indicative, from the financial standpoint, is the efficiency in the use of work stock. Work stock efficiency is usually measured by the acres of sugar cane per head. A similar measure may be satisfactorily used here. The inadequacy of present operations may be indicated partly by comparisons of work stock efficiency under existing conditions and under desired conditions. Since some of the tracts were operated partly by tractor labor, and the inclusion of these would have distorted the results, the averages presented here are for tracts operated largely by work stock.

The average acres of sugar cane per head of work stock were 5.8 and 4.9, for the fully operated and the partly operated land-use classes, respectively (Table 9).

TABLE 9. ACTUAL AND DESIRED ACRES OF SUGAR CANE PER HEAD OF WORK STOCK FOR DIFFERENT LAND-USE CLASSES, ACCORDING TO SIZE OF TRACTS

Size of tract	*Tracts with no idle cultivatable land*		*Tracts with no land in cultivation*		*Tracts with part of the cultivatable land idle*		*All tracts*	
	Acres of sugar cane per head		*Acres of sugar cane per head*		*Acres of sugar cane per head*		*Acres of sugar cane per head*	
	Actual	*Desired*	*Actual*	*Desired*	*Actual*	*Desired*	*Actual*	*Desired*
Small	5.3	6.8	....	7.7	3.7	6.2	4.8	6.7
Medium	7.1	8.5	....	10.7	5.8	9.3	6.4	9.0
Large	11.1	11.4	....	10.0	7.1	11.7	8.0	11.5
TOTAL	5.8	7.3	....	9.3	4.9	7.9	5.5	7.6

The increased acreage per head for all groups is derived from the expected larger acreage of sugar cane available and the improved efficiency that can be obtained from present work stock. These estimates are in very close accord with data from actual operations obtained by Reuss in 1929.[19] It should be recognized that heavy land requires more power than front land and should not have as high an acreage per head of work stock.[20] Operators are aware of this difference and, no doubt, have already taken it into consideration. Also, by mapping the location of some of the idle holdings it was possible to determine, in a general way, the technical condition of the soil. This indicated that no great variation prevailed between idle land and land in use.

A comparison of the efficiency of all tracts with that of fully operated tracts on which the present sugar cane acreage is adequate may throw additional light on the reliability of these estimates. The anticipated efficiency should conform closely to actual accomplishments as a maximum and may be expected to fall below it. Present operators undoubtedly have managerial qualifications and financial resources that will not be available to all operators.

The fully operated tracts, with adequate sugar cane acreage at present, had an average of 7.5, 10.2, and 10.2 acres per head of work stock for the small, medium, and large tracts, respectively. The estimate of 6.7 acres per head on small tracts is under this actual accomplishment. The same is true of medium-sized tracts as well. The large tracts have estimated 11.5 acres compared with an actual accomplishment of 10.2. Part of this discrepancy is no doubt an overstatement of the possibilities, and may have been influenced to some extent by the prospects of tractor and truck use to replace work stock. The rapid increase in the use of tractors undoubtedly has an influential effect upon estimating work stock needs.

MAN LABOR EFFICIENCY

The major intent of any restoration of the "Sugar Bowl" to agricultural use is for the purpose of providing people with a place to live and have some security from economic adversity. New technical developments have made sugar cane production relatively more profitable at the present time than it has been for more than a decade. Also, the return to rural areas seems inescapable for a large number of urban people at the pesent time. The sugar area has experienced a serious loss of human resources in the last decade. Any measure of recovery in the "Sugar Bowl" will be reflected in numerous other regions because of the exchange that will originate from such recovery.

Some degree of labor efficiency may be used as a measure of the present development and the one desired. The measure used in this study is sugar cane acreage per regular worker. A distinction is made between the regularly used or employed workers and those having seasonal employment such as hoeing and harvesting. These regular workers are a necessary part of the permanent organization. Their use is conditioned more by acreage, which is largely controllable, than by production, which is highly uncontrollable. While direct comparisons for all reporting farms may be made in the case of man labor, it should be recognized that shifts in power from work stock to tractors will result in regular labor displacement and permit a larger acreage per worker than would be possible if all of the power were furnished by work stock. The elimination of the unusual situations in arriving at averages makes the data comparable for our purpose.

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[19] Reuss, G. H. An Economic Study of Factors Affecting Farm Organization Power Utilization of Sugar Cane Farms, 1929. Louisiana Bulletin Number 215, Table 35, page 75, November, 1930.

[20] *Ibid.*, page 15. Front land is that land which is adjacent to the bayou in contrast to the heavy land which is next to the swamp.

In the use of man labor there is idle labor when operations cease. If it is a part of the regular family labor supply and remains on the land, the resulting physical efficiency of labor measured in acres per worker is lowered. When the size of unit increases to the point of using hired labor quite a different problem is presented than prevails on small farms. Under the hired labor type of organization, the labor supply is adjusted by the operator or management to the remunerative work. Excess laborers are discharged. This method makes possible a quick adjustment in the efficiency of labor, though it creates another problem of unemployment. The great loss of population in its adjustment to resources of the area has been shown already by Smith.[21] This explains to a large extent the adjustment in regular and extra labor that has taken place. Any return of the area to intensive production will recall a large number of workers, but it is highly probable that such a recall on other than family-sized farms will be only as rapid as high labor efficiency can be maintained.

The highest efficiency in the use of man labor was on medium-sized tracts, for both present and desired acreage. The lowest efficiency was for small tracts. Comparisons by land-use classes and size groups are available in Table 10. It is evident

TABLE 10. ACTUAL AND DESIRED ACRES OF SUGAR CANE PER REGULAR WORKER FOR DIFFERENT LAND-USE CLASSES, ACCORDING TO SIZE OF TRACT

Size of tract	*Tracts with no idle cultivatable land*		*Tracts with no land in cultivation*	
	Acres of sugar cane per worker		*Acres of sugar cane per worker*	
	Actual	*Desired*	*Actual*	*Desired*
Small	7.4	9.2	....	10.5
Medium	9.7	11.5	....	11.9
Large	9.2	9.9	....	10.8
TOTAL	8.1	9.9	....	11.1

Size of tract	*Tracts with part of cultivatable land idle*		*All tracts*	
	Acres of sugar cane per worker		*Acres of sugar cane per worker*	
	Actual	*Desired*	*Actual*	*Desired*
Small	4.8	7.8	6.5	8.8
Medium	8.1	11.6	8.8	11.6
Large	7.9	11.5	8.1	11.2
TOTAL	6.6	9.8	7.4	9.9

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[21] Smith, T. Lynn. The Growth of Population in Louisiana 1890 to 1930. Louisiana Bulletin Number 264, July, 1935. Figure 5, page 15 and Figure 8, page 18.

that relatively low average efficiency prevails at the present time, with the fully tilled tracts having a much better labor adjustment than have tracts with idle land. Apparently, a limit to increased efficiency is reached for large paltations. This is probably due to the loss of time in getting a large crew from field to field and from the farmstead to the field.

A comparison with tracts of similar size that were growing sugar cane and on which there was no desire to increase the acreage may be made. It is probable that these tracts have reached a high level of efficiency in the use of labor for cane production, since they did not expect to increase further. In fact, some of them were reducing their acreage. For small tracts of this classification on which regular schedules were obtained, the sugar cane acreage per regular worker was 10.4 compared with an average for all tracts of 8.8, and a maximum for the idle land-use class of 10.5. The medium-sized tracts of similar classification were handling an average of 14.0 acres per regular worker. This estimate was much above the average for all tracts and is undoubtedly a relatively high rate. The average for all tracts on the larger farms was identical with the average for those tracts now well adjusted in their sugar cane production.

Efficiency of man labor under the desired sugar cane acreage change is in close accord with actual accomplishments on tracts now fully operated and with no desired expansion in sugar cane acreage. Since, in most cases, the anticipated efficiency is below that being accomplished by a number of operators who have reached a well balanced organization, probably these operators realize that they will not have the capital or management to reach such high attainments.

Efficiency on the desired acreage is arrived at by using estimates of additional regular workers needed as well as extra sugar cane acreage. The averages of man labor efficiency for each land-use class are remarkably close and seem to be well within the limits of human accomplishment. The estimates for the tracts that were entirely idle are higher for the small- and medium-sized groups than for the other land-use classes. This may be due to the difficulty in estimating by those who furnished the information about the tracts. Also, it is quite possible that the owners of such tracts realized that labor would have to be relatively more efficient on these tracts in order to restore them to use, which would involve developing some land before it would bring in an immediate money income.

These various tests indicate rather conclusively that the changes suggested by operators and land owners of idle cultivatable land vary but little from actual accomplishments. Nor is there any great disparity between results obtained in the present study and those reported in previous studies of the same area. Since these actual and desired conditions are based upon aggregates, let us now examine these for the purpose of determining some of the net effects of such changes upon people involved, and additional capital goods involved.

Population and Land Use

An important controversial aspect of the entire study is the possibility of the area for the settlement of a large number of people. A very drastic decline in total population, particularly rural, occurred in the 13 parishes in which this study was made between 1910 and 1930. According to Smith, the total decline in unincorporated territory was 46,026 persons between 1910 and 1930, or 17.4 per cent.[22] During the same period urbanization gained in the area so that the net decline was 36,096, or

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[22] Smith, *op. cit.*, Appendix Table II, pages 50 and 51.

11.2 per cent.[28] This shift was largely a result of economic adversity and was characterized by rapid movement from rural areas and a relatively large decrease in negro population.[24] To some extent the restoration of the area to sugar cane production will require approximately its former population. This, however, will be conditioned largely by the manner in which the land is brought into use.

LAND OWNERSHIP

One difficulty confronting the sugar cane area in planning for the use of the land is the present condition of land ownership. The area has been in a period of liquidation since the appearance of appreciable acreages of idle land. The present position of corporate ownership must be taken into the picture in any serious planning for land use. Since corporate ownership has meant large unit ownership, as will be indicated presently, it is definitely allied with the present acreage of idle cultivatable land. While data on actual ownership is not at hand, some indication of the prevalence of corporate activity is available from information relating to the holders of real estate mortgages. For tracts with mortgage indebtedness and for which the creditor was definitely known, 67 per cent in number and 82 per cent in amount were held by corporations. While the holding of real estate mortgages is not commensurate with ownership of real estate, it is highly probable the corporate ownership has been increased considerably through foreclosure, both on the part of corporations outside of the areas, and of those in the area.

Previous analysis has indicated the dominance of small tracts in the fully operated land-use class in contrast to that of idle or partly idle classes. It is most probable that some small tracts have been annexed to larger tracts through foreclosure.

With corporate ownership go certain conditions that have the effect of forcing evacuation of the area when sugar cane production ceases. However, there are certain advantages that corporate ownership gives to those who remain in the area. Unemployment for a certain group is partly offset by a favorable condition, for corporations have aided in maintaining tax payments even though current production was greatly reduced. Land adjudicated to the State for delinquent taxes in the 11 parishes included in this study was only 7.2 per cent of the total, compared with a state average of 11.89 per cent, and was lower than any other type-of-farming area in the State.[25]

Further description of the ownership situation may be made for the land-use classes, including present tenure and color of owner. This should permit some conclusions with respect to the problem at hand. Of the usable data, 56 per cent of the tracts were fully operated; eight per cent were idle; and 36 per cent were partly operated. Owners operated 60 per cent of the tracts which had no idle land, and 61 per cent of the partly idle tracts. They comprised 96 per cent of the occupied idle tracts. For the owner-operated tracts, white owners held 80 per cent of the fully operated tracts, 86 per cent of the idle tracts, and 88 per cent of the partly operated tracts. A similar variation was found for tracts operated by tenants. White owners made up 87 per cent of the total for fully operated tracts, 90 per cent for idle tracts, and 91 per cent for the partly idle tracts. White owner-operators and landlords were relatively more numerous in the idle and partly idle land-use classes. Colored owner-operators and landlords were more numerous in the fully operated land-use classes.

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[23] *Ibid.*, Appendix Table I, pages 48 and 49.

[24] *Ibid.*, Appendix Table III, page 52.

[25] Montgomery, J. P. Tax Delinquency and Rural Land Adjudication in Louisiana, Unpublished thesis, pages 64-65. Louisiana State University.

Not only in number but in relative size is there a marked difference between white and colored owners in the different land-use classes. Since sample schedules were obtained largely for small tracts it is possible to generalize for the relative size of holdings, from a comparison of sample schedules with regular schedules. For all tracts, 27 per cent were sample schedules of white owners, and 56 per cent colored owners. In the fully operated land-use class white owners comprised only 35 per cent of the total number compared with 61 per cent for colored. The idle properties were held largely by white owners. Such properties as were held by colored owners were relatively small, 86 per cent of them were in the sample schedules group. Precisely the same relative position was found for tracts that were partly cultivated although the proportion of sample schedules was much smaller than for the other land-use classes.

Regular and Extra Workers

While no attempt was made in this survey to determine total population or even rural population, an effort was made to arrive at the number of regular workers employed in production, the total number of people so involved, and the anticipated changes under a restoration of the area to the desired sugar cane acreage. The data are from actual reports for all regular schedules and from partial enumeration for the sample schedules.

There were 32,152 regular workers and a total population in their families of 95,595 on the tracts covered in this survey. Of these, 43 per cent of the regular workers and a like proportion of persons in their families were on fully tilled tracts. There were a small number of workers residing on some of the tracts not in cultivation. A fairly wide variation existed in the distribution of workers according to size of tract under each land-use class (Table 11).

The large tracts had 43 per cent of the regular workers and 39 per cent of the population in their families, whereas the small tracts had 25 and 29 per cent, respectively. This indicates an added burden that falls on the operators of small tracts. The greatest variation between proportion of regular workers and population was on the tracts already fully operated where the small tracts had 39 per cent of the regular workers and 43 per cent of the population compared with 28 and 22 per cent respectively for the large tracts. These data apply only to the population on the tracts surveyed and may not have included all of the people in the families of regular workers. It is apparent from these data that the partly operated tracts maintained a better balance between workers and population than prevailed for the fully operated tracts. Let us see to what extent the estimates for desired sugar cane production alter this picture.

The additional regular workers needed to take care of the desired increase in cane acreage over the existing acreage was placed at 13,459, of which 11 per cent was for tracts that were fully operated, 20 per cent for those entirely idle, and 69 per cent for the partly idle tracts. The large plantations would require 50 per cent of the extra workers needed, the medium-sized tracts, 38 per cent; and the small tracts, 12 per cent.

This expansion in land use would call for an increased population in the families of regular workers of 43,867 persons, at the existing ratio of population to regular workers. Due to the slightly larger average size of family on the smaller tracts, the proportion of the population, by size of tract, was lower on the large tracts and higher on the small tracts than was found for the regular workers. This procedure in no way foretells what should be the development of the area from the standpoint

TABLE 11. NUMBER OF PEOPLE AND REGULAR WORKERS INVOLVED IN PRODUCTION FOR DIFFERENT LAND-USE CLASSES, ACCORDING TO SIZE OF TRACT

Size of tracts		Tracts with no idle cultivatable land				Tracts with all of cultivatable land idle			
		Total regular workers	*Average per report, all reports*	*Total number of people*	*Average per report, all reports*	*Total regular workers*	*Average per report, all reports*	*Total number of people*	*Average per report, all reports*
Small	Sample*	1,235	0.9	5,582	4.2	176	0.8	631	2.7
	Regular	4,137	2.5	12,262	7.3	31	0.2	157	1.1
Medium		4,708	6.9	14,333	21.2	39	0.3	191	1.4
Large		3,875	104.7	9,191	248.4	15	0.7	55	2.6
TOTAL		13,955	3.7	41,368	11.1	261	0.5	1,034	1.7

Size of tracts		Tracts with part of cultivatable land idle				All tracts			
		Total regular workers	*Average per report, all reports*	*Total number of people*	*Average per report, all reports*	*Total regular workers*	*Average per report, all reports*	*Total number of people*	*Average per report, all reports*
Small	Sample*	392	1.1	1,822	5.0	1,516	0.9	8,035	4.2
	Regular	2,473	2.5	7,000	7.1	6,641	2.4	19,419	6.9
Medium		5,298	6.0	16,584	18.9	10,045	6.0	31,108	18.5
Large		10,060	54.0	27,787	149.4	13,950	57.2	37,033	151.7
TOTAL		18,223	7.5	53,193	21.6	32,152	4.8	95,595	14.3

* Estimated from number of families reported.

of population. It is primarily a projection based upon existing regular labor and population and anticipated regular laborer needs. If large holdings were divided into tracts of a size usually operated by the family unit and returned to use in that manner, the total population for a given number of regular workers would be materially higher than if it were brought into cultivation by day laborers, a large percentage of whom are colored, and the total number of regular workers for a given cultivatable acreage would be increased.

At the time this study was made there were about 19,579 families on the tracts. Of these, 9,499, or 49 per cent, were white. Due to the higher average number of individuals per family, the total number of white individuals made up 53 per cent of the total. Since the migration prior to 1930 was more largely colored than white, it is to be expected that, if the area returns to cultivation along previous systems of management, the proportion will be greater for negro workers than for white.[26]

The anticipated need for regular workers and the probable extra people involved for different land-use classes according to size of tract groups is presented in Table 12.

TABLE 12. EXTRA REGULAR LABORERS AND PEOPLE IN REGULAR LABORERS FAMILIES FOR DESIRED SUGAR CANE ACREAGE

Size of tracts		*Tracts with no idle cultivatable land*		*Tracts with all of cultivatable land idle*	
		Extra regular workers needed	*Probable extra people involved*	*Extra regular workers needed*	*Probable extra people involved*
Small	Sample....	334	1,470	69	304
	Regular...	370	1,110	267	1,362
Medium...........		679	2,037	1,312	6,429
Large.............		114	274	987	3,652
TOTAL.......		1,499	4,891	2,635	11,747

Size of tracts		*Tracts with part of cultivatable land idle*		*All tracts*	
		Extra regular workers needed	*Probable extra people involved*	*Extra regular workers needed*	*Probable extra people involved*
Small	Sample....	107	471	510	2,245
	Regular...	433	1,212	1,070	3,684
Medium...........		3,145	9,750	5,136	18,216
Large.............		5,642	15,798	6,743	19,724
TOTAL.......		9,327	27,231	13,459	43,869

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[26] Smith, *op. cit.*, page 42.

IDLE WORKERS AND WORKERS EMPLOYED ELSEWHERE

In addition to regular workers and the members in their families, there were persons in families of idle or unemployed workers living on the tracts. Some of these were on relief; others were without work but were not receiving relief at the time of this study. In addition to this unemployed group there were families in which the regular workers were employed elsewhere. Many of these people were formerly employed directly or indirectly with the sugar cane industry and expect to go back into such employment again. They are not a part of the group who migrated from the area.

There were, on the tracts covered by regular schedules and on which the regular workers were idle or working elsewhere, appoximately 8,711 persons in 2,101 families. Of these, the persons in 770 families were receiving some relief, those in 389 families were idle but not receiving relief; and those in 942 families were working elsewhere. If we may assume the average number of workers per family to be not far from that of small tracts, this group had available about 2,600 regular workers, of whom only 1,155, or 44 per cent, were employed at the present time.

EXTRA WORKERS

Regular workers, workers in idle families, and workers employed elsewhere are only a part of the total labor supply of the area. A large number of extra workers are normally employed at hoeing and harvesting. The number of workers so employed in 1934, and the estimated number of extra workers needed for the expanded sugar cane acreage, adds to the probable hired labor picture. It is not possible in this study to differentiate between workers who were employed at hoeing and did not help in the harvesting and those who did. Most of the hoeing laborers were used also during the harvesting season. In addition, a large number were recruited from nearby areas.

In 1934, 13,521 extra workers during the hoeing season and 41,381 during the harvesting season were used on the tracts studied. Since no attempt was made to find out from the workers the number of operators for whom they worked during the season, it is to be expected that some duplication of workers has occurred. Since large tracts are the main employers of extra seasonal laborers, and they would be demanding such labor at about the same time, it is doubtful whether the duplication materially affects the results obtained. For the area as a whole, one extra hoe worker was used for each 15.3 acres of sugar cane, and one extra harvest worker for each 5.0 acres. In view of the fact that much of this labor came from small tracts in the area, from adjoining areas, and from urban centers of Louisiana and South Mississippi, the collapse of the sugar industry removed one important source of their annual income. The position may well be taken that many of these people have been among the number who entered cotton production during the period of favorable cotton price in the twenties, and probably have aided in precipitating the maladjustment experienced in the cotton areas in the opening of new lands. Obviously, the recovery of the sugar cane business from 1927 to 1933 was a strongly supporting factor in farm labor situation in Louisiana.

In order to find out from whence this extra labor for work in the sugar cane area was recruited a number of operators were interviewed concerning this practice. This practice must be considered if one is to appreciate the close contact that exists in the use of a labor supply, both rural and urban, that depends largely upon sugar cane production for a livelihood. While the findings of this study offer only a sketchy picture of what existed in the past, they lend ample support to the idea that past production has drawn heavily upon a highly mobile labor supply and was itself dependent upon such a labor condition for continuation.

Sources of Extra Workers

The data on the usual sources of extra workers for sugar cane production were obtained on a sample of the tracts, numbering 567. These were gathered from 11 of the 13 parishes, with the greatest number of interviews being from West Baton Rouge, St. Martin, and Iberia parishes. While the operators would not attempt to estimate the per cent or number of their extra workers from specified sources, they did indicate the different sources used by them. The number of sources suggested were limited to six: families on place, neighboring plantations, nearby towns, outside of the sugar area but in Louisiana, outside of the State, and transients. Of the operators interviewed 85 per cent reported using workers from one or more of these sources.

Of the operators using extra hired help 75 per cent obtained some or all of their workers from nearby towns, this being the most frequently reported source. Next in frequency were the workers from neighboring plantations. From this source 29 per cent of the operators obtained labor. It is customary for small operators of sugar cane farms as well as of other systems of farming to work on the large sugar cane plantations after their own crops are harvested. Also, the rapid decline in the sugar production left hired workers stranded, as well as operators. While it is the usual practice of large plantation operators not to allow idle workers to remain on the property this is not always adhered to as was pointed out in the discussion of the idle families still on the land.

The next most frequently reported source of workers was from families on the place. Not all of the persons in the families on the place were classed as regular workers. Additional workers, including women, come from these families for seasonal labor such as hoeing and stripping. This source was reported for 14 per cent of the tracts.

Workers from the state but outside of the sugar cane area, transients, and from outside of the state were reported for 6.2, 5.1, and 4.1 per cent of the tracts, respectively. These sources were most frequently reported by tracts in the parishes where the large plantation system is predominant and where labor is handled in large crews.

As the demand for extra workers declined, it might be expected that more remote sources would be the first to be seriously disturbed, particularly if large sugar cane operators were affected equally with smaller operators. Likewise, the expansion and return of the area from the low stage of 1926 has found the range of extra labor supply being pushed out farther and farther. Such a picture is a part of the normal activity under present business organization. Its counterpart might be to provide family-sized tracts so that the labor supply will be resident and thereby reduce the need for such a high degree of mobility in labor as is occasioned by the plantation economy. That such a change may bring a stability to the area that has long been lacking may well command the attention of public and private interests at the present time.

These data indicate the interdependence that exists between sugar cane growers and the labor supply of the area. The effects of change in the industry cannot be measured piecemeal without doing a serious injustice to the full consequence of such a change in border areas.

Just what labor of a seasonal nature would be needed if the desired cane acreage were to become a reality? On the basis of the estimates obtained, the number of extra hoeing laborers needed would be 16,933 or an increase of 125 per cent. This would permit one hoe worker for each 13.2 acres of cane which would be below the rate existing in 1934. Such a lower rate might be expected, for members of the family help more with such work on the family-sized units. The increase intended is predominantly on holdings where hired labor is normally used, hence it is to be expected that the use of more hoe labor per acre of additional cane would result.

An adequate supply of workers at harvest time is of greater concern usually than hoeing labor. The desired increase in acreage at anticipated yields would require 37,608 additional workers, or an increase of 91 per cent. On the new basis this would provide one additional harvest worker for each 5.1 acres of cane. It was the loss of employment for these particular workers that made the collapse of sugar production reach out into the nearby areas with devastating effect, for much of this labor came from the rim of the "Sugar Bowl" for seasonal employment. No doubt it is from this group that we find many of the relief element in the urban centers adjoining the "Sugar Bowl" as well as in the rural areas.[27]

EXTRA WORK STOCK NEEDED

We have pointed out some of the direct effects upon the use of labor and the drastic labor displacement that has taken place in the area. Some important indirect effects on labor elsewhere appear through the exchange of very tangible products. Among these are such items as work stock, equipment, buildings, milling equipment, fertilizer, fuel oil, bags, reagents, transportation services, and seed. Let us consider first the effect upon work stock. The area has always bought practically all of the mules used for power. Tractors have encroached slowly as a source of power, and will probably make very rapid inroads under present methods of operation. However, the main source of farm power at the present time is still mules. This work stock is purchased from outside of the South and, therefore, has been the outlet for the resources of other areas, notably portions of Kentucky, Tennessee, and Missouri.

Some very interesting data are available on the present use of work stock on the tracts studied, and estimated number needed to replace present faulty stock as well as to operate the desired increase in cultivated acreage. Part of the low efficiency of work stock already mentioned is due to their poor condition, for replacements have been made very slowly due to financial inability and uncertainty. This is a part of the recovery process, particularly when a business collapses during fairly prosperous times and starts its recovery during depressed times. The number of work stock on the tracts was placed at 29,347. Of these, the present operators estimated that 21 per cent needed replacing. At 1935 prices the cost per head to replace such animals would have been approximately $210. In addition to those tracts on which replacements were needed, there were some tracts that needed additional work stock for present operations, in spite of the fact that the average work stock efficiency for all tracts was comparatively low. This additional number needed was estimated at 1,714 head or a six per cent increase over present numbers. This is in accord with the increase in the trend of sugar cane acreage and the work stock needed to handle such expansion, especially since the bulk of the acreage is on tracts of more than 100 acres in size.

In order to expand the sugar cane acreage to the desired amount the operators and land owners estimated that it would take an additional 12,108 head of work stock. This represented an increase over work stock on hand of 41 per cent, of which 87 per cent was on tracts of medium and large size.

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[27] A tabulation of relief cases in Terrebonne parish furnished the writers by T. Lynn Smith, State Supervisor, Rural Research, Federal Emergency Relief Administration, shows that 40 per cent of the cases were engaged or usually engaged as farm laborers on sugar cane or general farms.

From these estimates it appears that the potential increase in work stock for present and desired acreage would be slightly over 20,000 head and would represent an estimated outlay of about four million dollars. Since this outlay or such parts as would occur annually goes into domestic trade, obviously the decline or rise of the sugar cane area as a market for work stock has a very critical effect upon the areas supplying such stock.

A second manner in which indirect benefit has been lost to other areas has been through the inability of the sugar cane area to purchase equipment or maintain its equipment supply. The operators of sugar cane farms are comparatively heavy purchasers of equipment and maintain a relatively high investment in equipment. As a part of the study certain information was obtained, through the use of the regular long schedules, concerning the present physical equipment, estimates for extra equipment needed for present operations and for the desired increase in acreage, and repairs for present equipment. Such reports should give a fairly good indication of the adequacy of equipment. The sample used was 8.3 per cent of the total number of regular schedules obtained, and is believed to be typical of tracts covered by this type of schedule. It would not be at all typical of tracts covered by sample schedules because of their relatively small size. For this reason the data presented in Table 13 are for the actual count of the sample obtained without adjustment for all tracts.

Clearly a considerable shortage of equipment exists in the area at present. This lack of equipment has no doubt been a factor in the lower yield obtained on many tracts, particularly smaller ones, because of inadequate tillage. The change in a few of the items deserves attention. The increases indicated for heavier equipment such as tractors and tractor drawn tools suggest the nature of the prevailing attitude about the equipment preferred. With existing mule prices (September, 1936) now about 50 per cent over estimates reported for 1935, it may be expected that larger operators will substitute tractors for mules. For this reason it becomes exceedingly difficult to project probable changes in equipment, if acreage expansion takes place rapidly.

In addition to these intended changes for items of equipment there is much equipment that may be put in good usable shape by new parts and overhauling. Under pressure for funds to meet current cash expenses it is probable that the postponement of equipment repair during the years of depression was necessary on many occasions to meet the emergency. For the tracts included here the cost of shop work and parts needed to repair present equipment was estimated at $79 per tract.

Clearly a return of land to agricultural use such as has occurred in the sugar cane area since 1927 has indirectly affected those individuals whose livelihood is dependent upon the handling of equipment. Practically all of this equipment, as was true in the case of work stock, comes from outside of the area. Any further development in equipment usage will be conditioned by the ability of the industry to justify outlays for new equipment.

A third indirect effect upon other areas may be found in the buildings available and needed for the desired increase in sugar cane acreage. We have gone into detailed description of the idle cultivatable land. Attention may now be given to the building resources now available or that may be made available by repairs. The heavy decline in population in the past two decades left many houses idle. Some of these, as will be explained, are available for use, either as they are or with repairs. A sample of the tracts for which the regular long schedules were obtained again has been used to give a generalization of this situation. For this sample there were 654

TABLE 13. PRESENT EQUIPMENT AND EXTRA NEEDED FOR PRESENT OPERATIONS AND FOR DESIRED INCREASE IN SUGAR CANE ACREAGE, 1934*
(as reported for 569 tracts)

Item of equipment	*Present number*	*Extra number needed for*			*Per cent increase*
		Present operations	*Desired increase*	*Total increase*	
Trucks	63	1	5	6	10
Trailers	24	0	3	3	12
Tractors	81	7	24	31	38
Tractor plows	75	7	24	31	41
Tractor shavers	16	2	11	13	81
Tractor disc cultivators	66	3	84	87	132
Plows	2,473	100	366	466	19
Disc cultivators	795	131	213	334	42
Disc harrows	259	58	112	170	66
Drag harrows	755	32	129	161	21
Magnolias	196	21	43	64	33
Middle breakers	542	83	162	245	45
Walking cultivators	416	76	155	231	56
Stubble diggers	157	48	60	108	69
Revolving harrows	56	9	27	36	64
Listers	175	48	76	124	71
Corn planters	377	116	76	192	51
2-Mule carts	403	56	120	176	44
4-Mule carts	425	6	56	62	15
Farm wagons	319	31	39	70	22
Harness gears	3,451	238	1,056	1,294	37
Cane loaders	58	1	21	22	38
Plant cane scrapers	86	7	23	30	35
Fertilizer distributors	121	57	65	122	101
Plant cane roller	42	8	32	40	95
Stubble cane shaver	154	28	53	81	53

* Data from regular long schedules.

operators' dwellings in use, and 14, or 2 per cent of the total, were idle. Apparently little abandonment of dwellings has occurred. A much more drastic abandonment, as may be expected, occurred for worker's houses. There were 2,179 worker's houses available in 1934, on the tracts included in the study. Of these, 304, or 14 per cent, were idle. Undoubtedly, houses deteriorate rapidly when idle and many houses that were formerly available for workers have been destroyed. That such must be true is indicated from estimates of the present cost to repair houses now on the place and of additional houses necessary for the labor supply needed if the idle land were returned to cultivation.

The operators of the tracts interviewed for this information estimated that 252 additional houses would be needed if the idle land were restored to cultivation. This represents an increase of about 12 per cent in the number of worker's houses. That houses, like equipment, have been allowed to go unrepaired is evident from the number of operators reporting repairs needed and the amount of such repairs. The estimated average cost of repairs per house, including dwelling, was $110. Since 77 per cent of the houses were worker's houses and the estimated present cost of new houses was placed at $332 each, the relative state of depletion becomes apparent.

While certain trade aspects for a great number of items such as fertilizer, fuel oil, bags, reagents, milling equipment, transportation equipment and services might be treated in a manner similar to that indicated for work stock, equipment, and certain buildings, it seems that the controversial point involved is clearly shown. In fact, many individuals will desire to express all of these possible exchanges in dollars, on the basis of physical changes desired. In order to do this in a reasonably satisfactory manner it is necessary to obtain, in addition to the physical data, estimates on the average requirement for each item and the present and prospective prices.

The physical data such as acreage, production, number of workers, and number of work stock have been presented throughout the analysis. For those who desired to interpret every exchange in dollars, the basic data are available. They will need to supply their own estimates of unit requirements and prices. These were not obtained except for a relatively few items such as equipment, work stock, and certain buildings.

MILLING FACILITIES

In this study, no special attention was given to the seasonal capacities of sugar factories now in operation, or to the condition of idle factories that were forced out of operation because of the decline in sugar cane production. It seems feasible, however, to examine the present status of milling facilities and the needed expansion, if the desired cane acreage were operated, so as to add further to the prevailing picture in the area.

A compilation of data from various sources together with information obtained from persons in the various parishes indicates that the total capacity for a season of 60 days, of mills now serving the area studied is approximately 3,817,300 tons. In addition, the capacity of 14 idle factories which are still intact is estimated at 562,700 tons.[28] The location of the active and inactive factories and their proximity to the highway system, and the railroad system is shown in Figure 3.[29]

The production of sugar cane on the basis of yields obtained in 1934 and the desired cane acreage would be 5,250,354 tons. Allowing 12½ per cent of this for seed purposes, there would remain 4,594,064 tons to be ground. Assuming that 200,000 tons of cane from parishes outside of this area, as revealed by 1934 mill records, would be ground by these mills, the total tonnage of mill cane would amount to 4,794,064 tons or 976,764 tons in excess of present mill capacity.

In view of the fact that the introduction of new varieties along with ideal growing conditions raised the average production for the State to 17.1 tons per acre in 1935, it appears necessary to estimate milling capacity on the basis of an upper limit of production as well as for average production. A future yield per acre of 17 tons may be justified due to the continuous increase in the acreage of higher yielding varieties of cane. At 17 tons per acre the production on the desired cane acreage in the area studied would be about 6,881,413 tons. After making allowances for seed

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[28] From information furnished by M. J. Voorhies, Senior Agricultural Economist, Sugar Section, Agricultural Adjustment Administration. Current changes reported by County Agents and factory owners.

[29] Acknowledgement should be made to the Land Utilization Division, Resettlement Administration, Baton Rouge, Louisiana, for the preparation of this map.

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LOUISIANA SUGAR CANE AREA

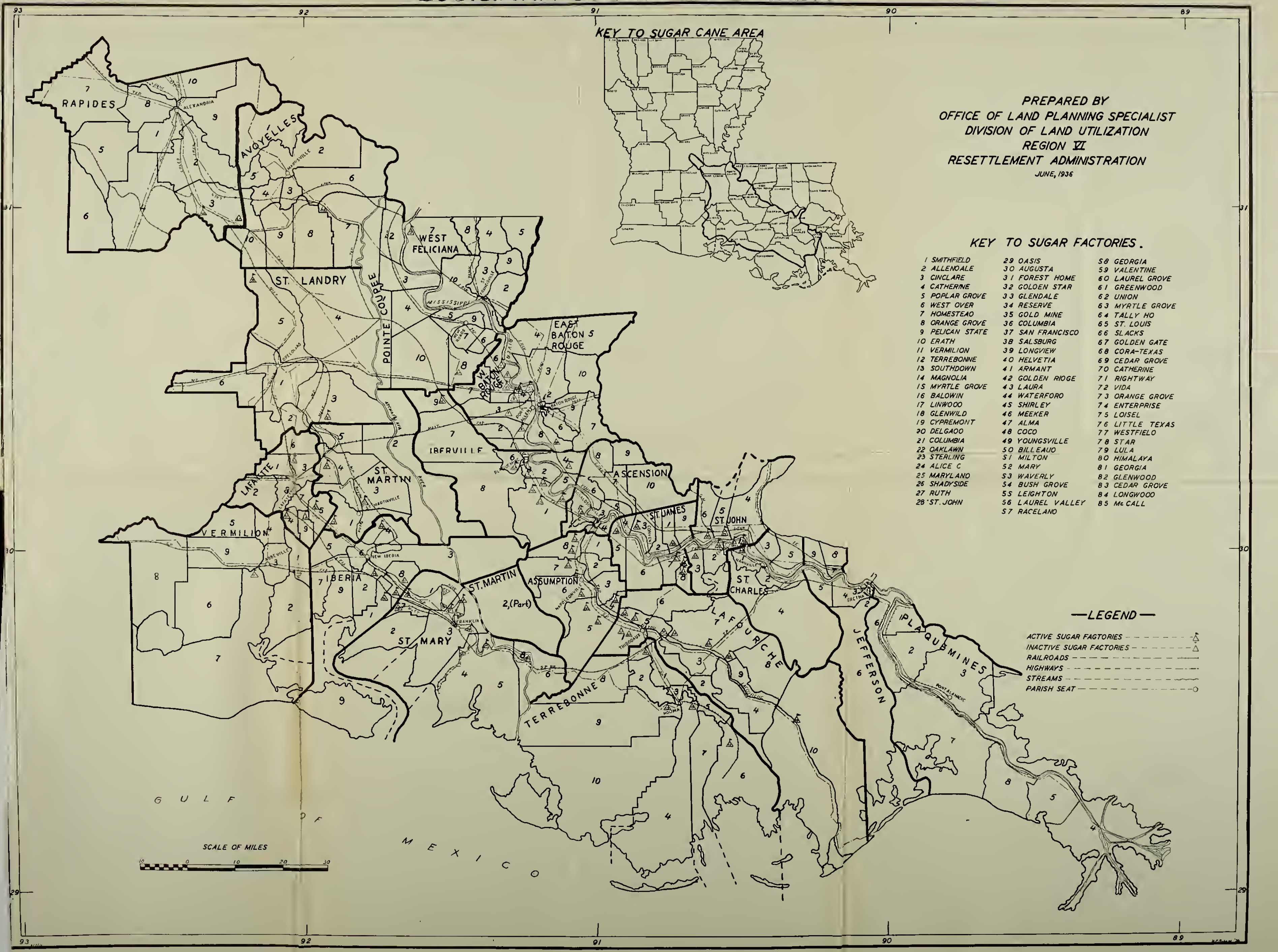

FIGURE 3. MILLING AND TRANSPORTATION FACILITIES OF THE SUGAR CANE AREA

cane and cane coming in from outside the area, approximately 6,221,237 tons would have to be taken care of by the mills. This would mean a needed increase in mill capacity of 2,403,937 tons.

TRANSPORTATION FACILITIES

Any attempt to construct a picture of what use may be made of land resources of the sugar cane area is not complete without some idea of conditions with which cane producers are confronted in the marketing of their crop. While some work was done by Reuss on this subject, it is not applicable to the more general conditions of the area since the data were for specific plantations.[30]

Transportation costs may be the determining factor in whether certain areas can afford to grow cane. Vast improvements in transportation facilities have been made in Louisiana in the past decade and have had a part in making agricultural use of the idle land in the sugar cane area more imperative than formerly. In order to determine the present accessibility of crop land to mills, information relating to the present methods of transportation was obtained on a sample of the tracts.

The methods of transportation include the use of teams, trucks, railroads, and barges. In this study the length of haul has been estimated from the field or tract's edge to the final destination while in the operator's possession. The data were obtained on 563 tracts located in 55 wards. Of these tracts, 498, or 88 per cent, reported cane hauled. The average length of haul was 9.4 miles. Sixty-two per cent of those reporting cane hauled used teams for part or all of their hauling. The average distance hauled by team was 1.1 miles. The next most frequently reported method of transportation was by rail, with 45.4 per cent of the tracts being included, and the average haul, 12.9 miles. The use of trucks for marketing cane has been one of the new developments of the sugar cane area. This method was reported in 36.6 per cent of the instances. The average haul by truck was 7.6 miles. Of only very minor use was barge transportation of sugar cane in the area from which this information was obtained. Less than one per cent of the tracts reported any cane hauled by this method. The average length of haul when barge transportation was used was 10.3 miles.

Since the bulk of the idle cultivatable land is in tracts with some of the land in cultivation and growing cane at the present time, it would appear that transportation problems arising from an increase in acreage and production would be largely the hauling on the plantation and, therefore, an individual matter. By locating on a map the idle land or properties containing idle land, it was possible, by inspection, to determine in a general way the extent to which such tracts were accessible to roads and mills. From observation, rather than actual measurement, it appeared that transportation facilities would not be greatly different for the present unused land than for the used land. This, however, will be conditioned to a great extent by the location of new mill facilities. The attempt to expand the acreage of sugar cane without proper expansion in mill facilities might result in serious transportation difficulties.

In addition to the method of transportation it was desirable to know what type of public road was used. The rapid increase in the use of trucks for hauling, much of which has occurred since 1926, has been made possible by the development of improved highways. Any developments towards an orderly resettlement of the area should be closely identified with the improved use of present road facilities. Also, the future expansion of the highway system should be coordinated with the return of agricultural land to use. The information on type of road over which the cane was transported from the plantation to the mill or loading station was obtained for the same sample tracts that were used for the method of transportation. Three types of road surface were recognized as follows: unimproved, gravel, and concrete.

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[30] Reuss, G. H. Hauling Cane by Wagon, Louisiana Circular Number 4, August, 1932.

Data on the type of road used were obtained from 410 of the 563 tracts, or 73 per cent. Some tracts had loading stations on them and made no use of public roads in the transportation of their sugar cane. Of those reporting the type of road used, 68.3 per cent indicated gravel; 34.1 per cent, unimproved; and 26.1 per cent, concrete. The average mileage for all tracts reporting was 3.85. The shortest mileage was 0.98 of unimproved road. The longest mileage was 5.12 of concrete road. The average haul on gravel road was 3.19 miles. A summary of total miles of road used by individual operators shows that gravel roads accounted for 56.5 per cent; concrete roads, 34.7 per cent; and the unimproved roads, 8.7 per cent.

The data on type of road and length of haul indicate that most of the present operators have access to roads of improved type. Those using unimproved roads have a comparatively short haul. The farm layout which predominates in the area facilitates access to public roads though it tends to make the haul on the farm a long one. There is usually a greater cost to small operators than to larger ones where loading stations for trucks or railroads are more centrally located.

SUMMARY STATEMENTS

This study has emphasized certain characteristics of present and prospective land use in the "Sugar Bowl." It presents a description in greater detail than has been done heretofore, of certain controversial issues that have aroused a keen public and private interest in recent years. Comparatively few issues have been considered, but these have been dealt with comprehensively. Since the omission of any appreciable detail would detract greatly from the analytical picture because of the highly integrated nature of the characteristics considered, it seems unwise to attempt any elaborate summary. However, a few brief statements may help to crystallize the procedure, issues and findings.

The idle cultivatable land in the sugar cane area has been caused by adverse economic and physical conditions of which mosaic disease, cane borer, the flood of 1927, and the financial collapse after 1929 are most important. Mosaic disease and cane borer caused serious damage through reductions in yield per acre. The flood reduced acreage drastically.

Since 1927 acreage and yield per acre have recovered remarkably in the face of adverse economic conditions. Much of this new development has been due to the introduction of improved varieties of sugar cane, to control measures for infestations, and to drainage and flood control. Unfavorable economic conditions have been greatly overcome by these technical changes.

The approach used in this study has been that of a comprehensive description of the existing cultivatable land area, its present use if in cultivation and its previous use if idle, and a possible alternative use of the idle land. The alternative use of a large area of idle land may be considered as a direct means of livelihood for a large number of people, some of whom may come from the present unemployed, and indirectly as an aid to other areas for those people who find an outlet for their resources through trade with the sugar cane area.

The data obtained in this study are highly comparable with those obtained by a number of other agencies. They have overcome many shortcomings of other data and have added a considerable amount of new information about the sugar cane area.

The data have been interpreted largely through the use of averages and percentages. Comparisons have been made between three land-use classes: tracts with no idle land, tracts with all of the cultivatable land idle, and tracts with part of the cultivatable land idle. Each land-use class is divided further into size groups. In one group are all tracts for which sample schedules were obtained. The regular schedules were divided according to acres in the tract into three groups as follows: 1-99, 100-999, 1,000 and over.

The idle cultivatable land is largely in tracts of land that are 100 acres or over in size; in fact, more than half of it is in tracts of 1,000 acres or over. Operators of small tracts have maintained or already returned their land to use to a greater degree than have operators of large tracts.

The present sugar cane acreage is divided about equally between tracts with no idle land and those with part of the cultivatable land idle. Only about 75 per cent of the tracts in each land-use class reported growing sugar cane. The larger the tracts the higher is the proportion growing sugar cane. Tracts in which a part of the cultivatable land is idle reported 30 to 50 per cent lower acreage of sugar cane per tract than did tracts with no idle land, indicating clearly the tendency of the return to production.

Small tracts have a relatively high proportion of plant cane, indicating a pronounced shift towards improved varieties, or an attempt to maintain yield by replacing stubble, or an expansion of the sugar cane acreage. Many tracts have returned their cultivatable land to use through a fairly rapid return to sugar cane. The present proportion of plant cane on such tracts is relatively high.

The yield per acre on small tracts is comparatively low for both actual and estimated normal. This, no doubt, accounts for the comparatively low proportion of land in cane and the complete absence of sugar cane on many tracts. Large tracts have a high actual and estimated normal yield per acre.

The desired sugar cane acreage for all tracts was an increase of 95.9 per cent over the present acreage. Seventy per cent of this increase was indicated for tracts with part of the cultivatable land idle, 16 per cent was on tracts with no idle land, and 14 per cent on tracts with all of the land idle. The largest relative increase in desired acreage over present acreage was for tracts of small or medium size.

Four tests of the reliability of the desired sugar cane acreage estimates were made. These consisted of (1) proportion of cultivatable land in sugar cane; (2) acres of cultivatable land per tracts; (3) work stock efficiency; (4) man labor efficiency.

The effect of an increase in sugar cane to the desired level was estimated to require an additional 13,459 regular workers. This increase would involve, at the current ratio of people to workers, about 44,000 people. In addition to the regular workers there would be extra seasonal workers for hoeing and harvesting. Estimates placed the extra workers needed for the hoeing season at an increase of 125 per cent, and for the harvesting season at 91 per cent. Most of these workers would come from nearby towns, part of whom are now on relief, from adjoining rural areas and from other type-of-farming sections. This constitutes a very direct effect upon the annual income normally obtained by these workers.

Indirectly any recovery in the sugar cane area will be reflected partly in other areas. The examination of capital resources indicated a serious shortage of work stock, equipment, and houses for present needs. If the desired acreage were attempted a considerable expansion would be made in these capital goods. Since they are largely the products of other areas it would have a far-reaching influence.

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DECEMBER, 1936 LOUISIANA BULLETIN No. 281

Sweet Potato Production in Louisiana

By JULIAN C. MILLER AND W. D. KIMBROUGH

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

SUMMARY AND RECOMMENDATIONS

1. The Porto Rico is the only variety of sweet potato recommended for commercial production in Louisiana.
2. Sandy to silt loam soils are best for high production, shape, and quality.
3. As sweet potatoes require little cultivation, thorough preparation is essential.
4. Under Louisiana conditions, mutations occur frequently.
5. Constant selection is necessary to maintain desirable skin and flesh color.
6. Seed potatoes should be treated before planting.
7. Six to eight bushels of potatoes should be bedded to produce plants for one acre.
8. In south Louisiana potatoes may be bedded in rows in the open for the main crop.
9. When beds are in field rows, vine cuttings should be made, rather than pulling slips.
10. Sweet potatoes should not be planted on the same land more often than every other year.
11. From 400 to 600 pounds of 4-12-4 or 4-8-4 fertilizer should be applied per acre.
12. Ridged rows 12 to 14 inches high and 3½ to 4 feet apart should be used. Plants should be spaced 12 inches apart in the row.
13. Since time of setting to the field influences the shape of potatoes, the first half of June is the best time to plant in the commercial district of Louisiana.
14. To control weeds about two shallow cultivations are usually necessary.
15. Sweet potatoes should be harvested before frost.
16. October is usually the best time to harvest the main crop as it is usually dry and warm.
17. Care must be taken to prevent bruising of potatoes at harvest time.
18. Marketable potatoes should be carefully graded, picked up and placed in storage crates.
19. To cure potatoes keep them at a temperature of 80° to 85° F. for 10 to 20 days immediately after digging.
20. In south Louisiana artificial heat is unnecessary for curing potatoes harvested in October.
21. After curing, sweet potatoes should be kept at temperatures ranging from 50° to 60° F.
22. Potatoes which are prepared for market should be cleaned thoroughly, well graded and packed attractively.

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IMPORTANCE

The sweet potato is the most important vegetable crop in the South. The average annual production of this crop in the southern states for the five year period from 1931 to 1936 was 62,268,600 bushels, of which Louisiana produced 5,695,000 bushels. The sweet potato is a major food crop for the people in the South and is also used quite extensively as a feed for livestock. The word potato usually means sweet potato in the South in contrast to meaning Irish or white potato in other sections of the United States. This crop is comparatively easy to grow, for even if it receives very little care some potatoes will be produced. For best results, however, good cultural practices should be followed.

The possibilities of the development of the sweet potato starch industry in the South seem very promising at present. If it does develop, the further production of this crop will be stimulated. The best varieties of sweet potatoes for starch production are not those most suitable for culinary purposes.

INTRODUCTION

Although the sweet potato has been the subject of much investigational work, there are many problems yet to be solved. In relation to its importance, this crop has been neglected, due in all probability to the fact that it has been easy to grow and thus has been more or less taken for granted.

The Louisiana Agricultural Experiment Station has conducted several experimental projects with fertilizing, spacing, time of planting, selection, mutations, and storage of sweet potatoes, and expects to continue work with this important crop. Experimental sweet potato plots have been located at Sunset and at Baton Rouge, on soil of the Lintonia silt loam type. Plots 40 by 3½ feet were used. Each treatment was replicated five times in order to partially overcome variability of the soil. The Porto Rico variety and its mutations were used exclusively in the investigations.

It is the purpose of this bulletin to give general recommendations and directions necessary for the production of sweet potatoes, in addition to reporting the results of experimental work conducted.

TYPES OF SWEET POTATOES

Sweet potatoes may be divided into three general types which may be designated as moist, intermediate, and dry. The moist type, which is commonly grown in the South, is often called a yam. The true yam, however, is an entirely different plant from any variety of sweet potato, and is seldom grown in the United States. The moist type becomes soft when it is cooked. This is attributed to the formation of dextrins which are not formed as extensively in the dry type. Immediately after digging, this type of potato does not get as soft after cooking as it does after a period of curing and storing. The dry sweet potato is grown and generally preferred in the North, although the southern type is rapidly increasing in favor in that section and will probably become even more popular. This type tends to be choky when eaten. The intermediate varieties must be stored for several weeks before they become soft when cooked. These varieties are best for starch production.

IMPORTANT VARIETIES

A large number of sweet potato varieties are known at present, but only those few which are considered important will be discussed in this bulletin.

MOIST TYPE

Porto Rico—This variety is by far the most important one grown in the South. It is probably best adapted to the lower South, although it does well throughout the cotton belt. It is the only variety recommended at present for commercial planting in Louisiana.

Two mutations of the Porto Rico are very good for eating purposes, but are not recommended for planting for commercial shipment. These are the Porto Orado (Coker's Gold Skin) and the Porto Morado, which is often erroneously called Improved Porto Rico. The Porto Morado has some purple pigment in the skin and the Porto Orado has a yellow skin, but in other respects they are quite similiar to the Porto Rico.

Nancy Hall—This variety is still grown quite extensively, especially in the northern part of the South. It was once much more important than it is at present but has been replaced with the Porto Rico in many sections.

DRY TYPE

Big Stem Jersey, Yellow Jersey, Priestley Jersey—These varieties are not grown extensively in the South, although limited quantities are produced for northern shipment. They produce very well in this section, but are difficult to keep free from black rot and do not seem to be adapted to storage in the South.

INTERMEDIATE TYPE

Triumph—This variety is grown to some extent for early shipment to the North. At present, it is considered to be the most promising potato for starch production. The Purple Stem, a mutation of this variety, is increasing in importance and may eventually replace the parent type.

Southern Queen—Though once popular, this variety is not likely to regain its importance unless it has merit as a starch potato.

Porto Blanco—A mutation of the Porto Rico, this is a vigorous growing, high producing potato which is especially suitable for feeding to dairy cattle. It has a high starch content and is promising for starch manufacture.

SOIL

Sweet potatoes can be grown with fair success on a wide variety of soil types provided the soil is well drained. In general, light sandy loam soil produces the best quality and shape of potatoes. Mississippi River alluvial land is not considered suitable for quality production of this crop. In Louisiana, silt loam soils are largely used for commercial production, and give high yields. Heavy yields of sweet potatoes cannot be expected on very sandy soils.

PREPARATION OF THE SOIL

Loose, well prepared soil is essential for successfully growing sweet potatoes because the crop is produced underground and is not cultivated extensively. Ridged rows on which the plants are to be set should be thrown up when the ground is prepared. Rows 3½ to 4 feet wide and 12 to 14 inches high are recommended for Louisiana.

MUTATIONS

There is quite a common complaint in Louisiana that sweet potatoes are not uniformly true to variety. A grower may harvest a mixture of potatoes from a field which has been planted to the Porto Rico variety. This may be due to bedding potatoes of more than one variety for plant production and thus getting a mixture planted in the field. In most cases, however, the grower has planted only the Porto Rico, using his own seed with no attention to selection for a number of years. When his crop seems to be a mixture of varieties he concludes that his potatoes have run out and a new source of seed is necessary. This may not be true, however. It has been found at the Louisiana Agricultural Experiment Station that mutations, or sports, occur rather frequently in fields of the Porto Rico variety in this state. A mutation of the Porto Rico is illustrated in Figure 1. Because of the occurrence of these variations, or mutations, it is often believed by growers that potatoes of different colors will cross or mix if planted close to each other, just as yellow and white corn will. This belief is erroneous, however, because varieties cannot cross unless blooms and seed are produced and a cross can be produced only from a seed which was the result of a cross. This does not happen under field conditions in this state.

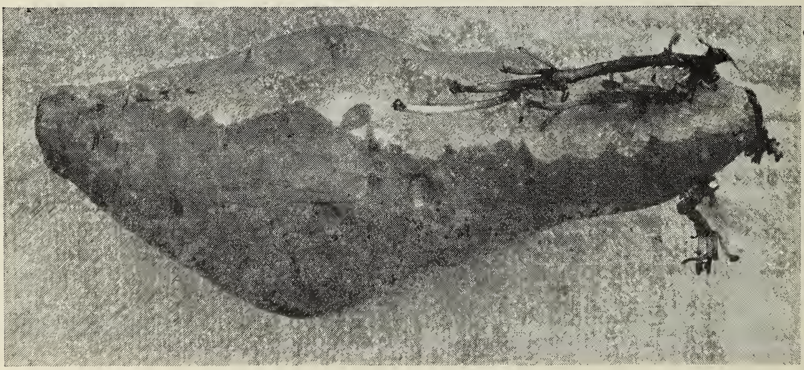

Fig. 1. A potato, half of which has mutated to the Porto Orado type. Sprouts grown from the light-colored area and planted, produced potatoes of similar color. Those from lower or darker area produced normal Porto Rico potatoes.

Some of the mutations which have been found produce plants earlier than the parent variety. If early slips are set out to make plants from which vine cuttings will later be taken, the mutations may be rapidly multiplied.

MAINTENANCE OF SEED STOCK BY SELECTION

The proper selection of seed is very important, though often badly neglected. Selected Porto Rico sweet potatoes for use as seed stock are in great demand, but are just beginning to be available. Many growers must produce plants from sweet potatoes which they have on hand. Under these conditions the crop can be greatly improved by selection of the potatoes to be bedded for plant production. The frequency with which mutations occur emphasizes the necessity for selection of seed stock, if the purity of the variety is to be maintained. Even with the best strain of Porto Rico available, proper selection of seed stock must be practiced if the high standard is to be kept up.

Selection for desirable skin color is not difficult if the potatoes are clean, and should not be neglected. Potatoes with an excessive number of small lateral roots should be closely examined, as they are likely to be off type in both skin and flesh color. To be sure that the inside color is all right, a chip should be cut from the potato near the end by which it was attached to the plant and the flesh color examined. Usually the end to be chipped may be identified by the presence of sprouts, but if it is impossible to tell which is the right end, both of them should be chipped. If the desired color is present at either end, the interior color is all right. Potatoes that do not have typical orange-colored flesh should not be used for plant production. The flesh color of a Porto Rico varies from one end to the other, with the best color being found at the end by which it is attached to the plant. Turnip-shaped potatoes of the Porto Rico variety seem to be a little better colored internally than longer ones, but as long as good color is present the degree makes no difference in seed selection. It is hard to over-emphasize the importance of the examination for flesh and skin color and the selection of seed sweet potatoes on that basis. If this selection is carried out there will be no cumulative effect of the mutations that occur and the strain will not run out on that account. The farmer may thus have his own selection of sweet potatoes.

The shape of the potatoes used to bed apparently has no effect on the shape of those grown from the plants produced. Because of convenience in handling and a probable production of more plants per unit amount, potatoes medium long to long in shape are usually bedded for plant production. Small potatoes are as good for seed purposes as larger ones, provided they come from high-yielding hills. This is shown in Table 1. Small potatoes produce more slips per bushel than larger ones. The continued use of small potatoes for propagation purposes over a period of years is not advisable, however, as there is danger of emphasizing some disease or other factor which may have caused them to be small. The safest procedure in trying to improve a strain is to bed only No. 1 potatoes.

Tests to determine the effect on crop yield of the location of slips on the bedded potato showed that plants from distal end slips produced as high yields as did those from the proximal end. These results are given in Table I.

TABLE I. SOURCE OF SLIP TEST—THREE-YEAR AVERAGE

SOURCE OF SLIP	YIELD IN BUSHELS PER ACRE			
	Jumbos	*No. 1s*	*No. 2s*	*Culls*
No. 1 potatoes	12.7	309.8	46.2	27.8
No. 2 potatoes	29.1	312.7	34.8	26.2
Proximal end	23.6	311.7	32.7	26.6
Distal end	58.7	329.2	32.2	22.9

SEED TREATMENT

All potatoes should be treated before being bedded, for although they may appear to be entirely free of disease, spores are nearly sure to be adhering to the skin. It is recommended that the seed potatoes be soaked for eight minutes in a solution containing one part of corrosive sublimate (bichloride of mercury) to 1000 parts of water. This means one ounce of corrosive sublimate to eight gallons of water. The crystals of corrosive sublimate should be dissolved in a small amount of hot water in a non-metal container, then added to the proper volume of water in a large barrel or other wooden container. *Metal containers should not be used* because they take the corrosive sublimate out of solution. The potatoes may be placed in crates or sacks and dipped in the solution. When they are removed, the solution should be allowed to drain back into the container. It is not necessary to rinse the potatoes after treatment. After a solution has been used for several times, it should be replaced with a fresh one. Thirty-two gallons of solution should be sufficient to treat about twenty bushels of potatoes.

Corrosive sublimate is a deadly poison and should be handled accordingly. It should not be left where animals can get to it, nor should the treated potatoes be used for food of any kind. There is no seed treatment known that will prevent the spread of blackrot from roots actually infected with this disease. All roots affected with disease should be discarded before the seed is treated.

BEDDING SEED POTATOES

The quantity of potatoes to bed will depend on the size of potatoes and the acreage to be planted. From 1500 to 2000 plants may be expected per bushel of No. 1 potatoes of the Porto Rico variety for the entire season that slips may be pulled. A bushel of No. 1 potatoes will require about 15 square feet in the plant bed. A bushel of No. 2s will require more space and will produce more plants. If three pullings of slips are to be made, not quite half of the plants may be expected at the first pulling if the bed is well covered with plants at that time. When slips are to be set 12 inches apart in rows 3½ feet wide, 6 to 8 bushels of sweet potatoes should be bedded to produce plants for an acre. If only the first planted potatoes are to be grown from slips and the rest from vine cuttings from these, enough potatoes to plant about one-sixth of the desired acreage should be bedded. When sweet potatoes are bedded they should be placed close together but not allowed to touch.

In the northern part of Louisiana some source of bottom heat in the bed is necessary to get slips for early planting. Fresh manure of a kind that will heat is probably best for the small plant bed. Flue-heated hot beds in which wood can be burned are probably the most economical where a large quantity of plants is needed. Plants grown in hot beds are usually placed in sand and covered with it to a depth of about four inches. Straw or similar material should be kept handy to protect the plants in case of a freeze.

In south Louisiana it is not necessary to have any specially constructed beds for the production of sweet potato plants. They can be produced in the open without protection early enough to be set in the field at the normal commercial planting time. The potatoes may be bedded in regular rows and covered with soil. Slips are not usually pulled when this method is used, but vine cuttings are made from the growth produced.

SLIPS VS. VINE CUTTINGS

The common practice in planting sweet potatoes is to pull slips or draws from the plant bed and set them to the field. Quite often vine cuttings are made from plants grown from early set slips. Vine cutting will cause a reduction in yield of the plants from which cuttings are made.

In south Louisiana the recommended practice is to grow plants in field rows and make vine cuttings instead of pulling slips. This is done largely for sanitary reasons. If slips are pulled, the lower end is in contact with the mother potato and any disease organisms present there may be transferred with the slips. The vine cuttings are made above ground and so are much less likely to spread diseases or the sweet potato weevil. Under favorable conditions, vine cuttings will live equally as well as slips and will produce as high yields.

ROTATION

As with most crops, rotation is necessary if best results are to be expected from sweet potatoes. This crop is generally recognized as being a heavy feeder and may deplete the nutrient reserves in the soil if it is grown on the same soil without fertilization for a number of years. As the shape of the roots produced depends to some extent on the looseness of the soil, green cover crops turned under are beneficial, especially on the heavier types of soil. If sweet potatoes are grown year after year on the same soil, diseases and insects will be a much more serious problem than if rotation is practiced.

FERTILIZATION

Sweet potatoes will grow and usually produce a crop, even on poor soils, without fertilization, but best results cannot be expected under these conditions. Good lands is essential if high yields are to be obtained.

Fertilizer experiments were conducted for three years at the Louisiana Agricultural Experiment Station and at Sunset, Louisiana, to determine the fertilizer requirements of sweet potatoes at these places. The type of soil on which the plots were located was Lintonia silt loam. At Louisiana State University, the land had been

TABLE 2. RATE OF NITROGEN TEST—THREE-YEAR AVERAGE

*Treatment** *NPK*	*Where Grown*	YIELD IN BUSHELS PER ACRE				*Total Yield*	*Increase from Nitrogen of U. S. 1's in Bu. per Acre*
		Jumbos	*U. S. 1*	*U. S. 2*	*Culls*		
6–8–4	Sunset.......	12.4	300.7	41.9	41.0	396.0	26.5
4–8–4	Sunset.......	16.3	276.3	46.5	49.3	388.4	2.1
2–8–4	Sunset.......	10.7	275.6	44.8	44.6	375.7	1.4
0–8–4	Sunset.......	15.7	274.2	44.9	48.7	383.5	....
0–0–0	Sunset.......	3.4	225.1	47.3	43.9	319.7	....
6–8–4	L. S. U.......	64.4	416.1	34.6	29.0	544.1	41.2
4–8–4	L. S. U.......	54.5	414.3	40.2	27.2	536.2	39.5
2–8–4	L. S. U.......	37.4	398.8	46.9	34.8	517.9	24.0
0–8–4	L. S. U.......	28.1	374.8	34.4	33.3	470.6	....
0–0–0	L. S. U.......	25.5	357.1	37.8	29.2	449.6	....

*Fertilizer applied at the rate of 800 pounds per acre.

used for vegetable production for a number of years and had been fertilized regularly with a complete fertilizer. At Sunset the land had been in sweet potatoes for a number of years and had not been fertilized. Legume cover crops were grown at each place and turned under prior to setting in sweet potato plants.

The results of the fertilizer experiments are shown in Tables 2 through 7. In studying the results of fertilizer tests with sweet potatoes, the total yield, as well as the yield of No. 1 potatoes, should be considered. The time of digging will materially affect the grade. As sweet potatoes are graded by hand, there is more variation than there would be if mechanical graders could be used.

TABLE 3. RATE OF PHOSPHORUS TEST—THREE-YEAR AVERAGE

*Treatment** *NPK*	*Where Grown*	YIELD IN BUSHELS PER ACRE				*Total Yield*	*Increase of U. S. 1's in Bu. per Acre from Phosphorus*
		Jumbos	*U. S. 1*	*U. S. 2*	*Culls*		
4–12–4	Sunset.......	12.0	308.9	48.0	49.5	418.4	53.5
4–8–4	Sunset.......	8.7	288.0	45.4	53.6	395.7	32.6
4–4–4	Sunset.......	6.4	279.7	49.4	52.5	388.0	24.3
4–0–4	Sunset.......	6.9	255.4	48.3	55.3	365.9	....
0–0–0	Sunset.......	5.1	226.3	49.9	52.1	333.4	....
4–12–4	L. S. U.......	47.8	405.4	33.6	25.6	512.4	11.5
4–8–4	L. S. U.......	61.5	381.6	35.6	22.5	501.2	−12.3
4–4–4	L. S. U.......	50.8	383.2	33.5	24.9	492.4	−10.7
4–0–4	L. S. U.......	64.2	393.9	37.0	22.5	517.6	....
0–0–0	L. S. U.......	41.0	331.6	39.0	24.6	436.2	....

*Fertilizer applied at the rate of 800 pound per acre.

The results obtained from the fertilizer tests are variable. In general the application of fertilizer resulted in increased yields. Yields were higher at Louisiana State University than at Sunset, largely because the plants were set to the field earlier. The response to fertilizer was not as great at Louisiana State University as at Sunset. This is probably explained by the fact that at Louisiana State University the soil had been fertilized for other crops and there was some residual effect.

The response to nitrogen was more marked at Louisiana State University than at Sunset. This was likely due to the heavier yields produced at Louisiana State University. The results of the nitrogen test indicate that some nitrogen is beneficial but the response to nitrogen was not as great as might be expected. Sweet potatoes, a long-season crop, are heavy feeders and are grown at a time when nitrifying organisms in the soil are most active. In connection with nitrogen fertilization it should be stated that heavy application of nitrogen when plenty of moisture is available may cause excessive vine growth which may make the crop mature later and reduce the yields.

The response to phosphorus was greater at Sunset than at Louisiana State University. At Louisiana State University the residual effect of phorphorus applied evidently nullified the benefit of its application for the duration of the experiment. At Sunset the application of phosphorus was more beneficial because there was no residual effect at the start. It should be stated, however, that a greater response was obtained there the first year of the test than for the other two years. This means that phosphorous is especially important on new land or on land that has not been fertilized for a number of years. Much of the new land is very deficient in phosphorus and responses to its application are very marked.

The results of the potash test were more erratic than those of the other two elements tested. No response was obtained at Louisiana State University. This again is probably explained by the residual effect of previous applications of potash. It was more effective at Sunset than at Louisiana State University, but the response was not very marked there.

TABLE 4. RATE OF POTASH TEST—THREE-YEAR AVERAGE

*Treatment** *NPK*	*Where Grown*	YIELD IN BUSHELS PER ACRE				*Total Yield*	*Increase of U. S. 1s in Bu. per Acre from Potash*
		Jumbos	*U. S. 1s*	*U. S. 2s*	*Culls*		
4–8–10	Sunset.......	11.5	321.2	44.6	43.6	420.1	32.3
4–8–8	Sunset.......	16.3	288.2	49.6	43.0	397.1	–1.7
4–8–6	Sunset.......	9.1	307.6	46.7	40.4	403.8	17.7
4–8–4	Sunset.......	8.3	313.9	43.2	41.0	406.4	24.0
4–8–2	Sunset.......	5.1	296.6	44.6	43.5	389.8	6.7
4–8–0	Sunset.......	7.5	289.9	47.6	43.0	388.0	....
0–0–0	Sunset.......	7.5	230.8	47.9	43.5	329.7	....
4–8–10	L. S. U.......	64.4	375.5	38.6	27.4	505.9	6.6
4–8–8	L. S. U.......	59.2	352.6	33.4	25.1	470.3	–16.3
4–8–6	L. S. U.......	54.8	331.0	38.9	24.4	449.1	–37.9
4–8–4	L. S. U.......	51.2	369.1	44.1	21.9	486.3	0.2
4–8–2	L. S. U.......	66.1	372.8	41.3	21.5	501.7	3.8
4–8–0	L. S. U.......	65.0	368.9	36.3	25.6	495.8	....
0–0–0	L. S. U.......	32.2	309.8	33.0	24.8	399.8	....

*Fertilizer applied at the rate of 800 pounds per acre.

The tests with rate of application of complete fertilizer showed that a profitable increase in yield was obtained by the application of fertilizer. On the soil where these tests were conducted 400 pounds per acre of 4-8-4 was sufficient. On poorer soils it seems probable that slightly heavier applications would be beneficial and it is suggested that 600 pounds per acre is not too much.

There was considerable interest in concentrated fertilizers at the time these tests were started. Some of the materials used at first became unavailable and the number of treatments was reduced accordingly. Yields obtained show no significant difference in concentrated fertilizers and the standard 4-8-4. Interest in concentrated fertilizers seems to be waning, but the data presented indicate that they can be used successfully with sweet potatoes.

The results of the shrimp meal and cottonseed meal test show an increase in yield of the fertilized plots over the check plots. There was no significant difference between the various fertilizer treatments and the standard 4-8-4. The addition of potash did not increase the yield.

DISCUSSION OF FERTILIZER RESULTS

The results of the fertilizer experiments showed that sweet potato yields were increased by the application of commercial fertilizers. Larger increases were obtained from the application of phosphorus than from nitrogen or potash. The application of small amounts of nitrogen was beneficial. The value of potash was doubtful on the soils on which the experiments were conducted. Tests in other sections of the country have shown the advantages of potash and there undoubtedly are soils in Louisiana on which sweet potatoes are grown which will respond to potash. The application of a small amount of potash cannot be harmful and will prevent the reserves in the soil from being depleted. The more easily obtained commercial fertilizers are complete fertilizers. If home mixing of fertilizers is practiced, potash may be left out when fertilizer is to be applied to land that does not respond to this element. In general, it is best to apply a complete fertilizer.

TABLE 5. RATE OF APPLICATION OF COMPLETE FERTILIZER TEST (4-8-4)
THREE-YEAR AVERAGE

Rate of Application Pounds per acre	*Where Grown*	YIELD IN BUSHELS PER ACRE				*Total Yield*	*Increase of U. S. 1s in Bu. per Acre from Fertilizer*
		Jumbos	*U. S. 1s*	*U. S. 2s*	*Culls*		
1000	Sunset	9.4	300.0	45.7	47.8	402.9	78.2
800	Sunset	17.4	276.9	44.9	45.1	392.5	54.2
600	Sunset	7.1	284.2	42.7	44.1	378.1	62.4
400	Sunset	10.6	273.2	44.1	45.5	373.4	51.4
200	Sunset	6.0	252.5	48.2	48.7	355.4	30.7
000	Sunset	1.8	221.8	47.7	41.4	312.7	....
1000	L. S. U	87.0	401.1	41.6	23.3	553.0	80.1
800	L. S. U.	71.6	378.7	40.9	24.3	515.5	57.7
600	L. S. U.	64.1	361.1	36.8	20.6	482.6	40.1
400	L. S. U.	44.9	371.7	38.4	23.3	478.3	50.7
200	L. S. U.	33.3	356.2	37.1	21.1	461.8	35.2
000	L. S. U.	50.3	321.0	34.7	18.8	424.8	....

The application of fertilizer that is recommended for sweet potatoes in Louisiana is from 400 to 600 pounds per acre of 4-12-4 or 4-8-4. This should be applied in the row and the rows bedded up one to two weeks before cuttings or slips are set to the field.

SPACING

It is generally recommended that sweet potatoes be planted in rows 3½ to 4 feet apart. Distance apart in the row will depend to some extent on the type of land planted. Plants should be spaced further apart on poor soil than on good soil. Wider spacing tends toward production of more jumbos on good soil. Results of an experiment conducted at Louisiana State University to determine the best spacing distance are shown in Table 8. The 12-inch spacing was best and is generally recommended for the commercial producing districts of Louisiana.

TIME OF SETTING CUTTINGS OR SLIPS

Sweet potatoes may be set in the field as soon as danger from frost is over. When potatoes planted on different dates were dug at approximately the same time, it was found that those planted earliest gave the heaviest yields. These results are given in Table 9. However, the total yield is not always the most important consid-

TABLE 6. CONCENTRATED FERTILIZER TEST—THREE-YEAR AVERAGE (Rate Based on N Equivalent in 800 Pounds of 4-8-4)

Treatment	*Where Grown*	*Jumbos*	*U. S. 1s*	*U. S. 2s*	*Culls*	*Total Yield*
Ammophoska 10–30–10	Sunset	1.2	213.0	58.1	48.1	320.4
Nitrophoska 12–24–12	Sunset	2.1	196.9	60.2	44.0	303.2
Nitrophoska 1½(12–24–12)	Sunset	2.5	225.4	61.0	38.7	327.6
Nitrophoska 10–20–20	Sunset	3.4	238.7	65.0	47.8	354.3
NPK 4–8–4	Sunset	3.1	213.5	58.9	47.2	322.7
Ammophoska 10–30–10	L. S. U.	73.6	368.3	34.3	20.6	496.8
Nitrophoska 12–24–12	L. S. U.	63.4	375.6	37.2	22.4	498.6
Nitrophoska 1½(12–24–12)	L. S. U.	74.2	348.7	28.7	21.6	473.2
Nitrophoska. 10–20–20	L. S. U.	59.9	371.7	32.1	26.1	489.8
NPK 4–8–4	L. S. U.	45.6	397.8	33.6	21.4	498.4

TABLE 7. SHRIMP MEAL AND COTTON SEED MEAL TEST—THREE-YEAR AVERAGE (800 Pounds Per Acre Plus Potash Where Added)

Treatment	*Where Grown*	*Jumbos*	*U. S. 1s*	*U. S. 2s*	*Culls*	*Total Yield*
Phos. 2 parts SM 1 part	Sunset	17.1	262.6	44.8	42.7	367.2
Phos. 2 parts SM 1 part 4%K	Sunset	15.4	260.2	51.4	45.2	372.2
Phos. 3 parts SM 2 parts	Sunset	13.9	238.9	47.2	42.5	342.5
Phos. 2 parts CSM 1 part	Sunset	5.9	247.4	50.3	37.9	341.5
Phos. 2 parts CSM 1 part 4%K.	Sunset	15.9	255.0	47.5	45.4	363.8
NPK 4–8–4	Sunset	20.5	249.6	56.8	47.2	374.1
Check	Sunset	5.2	205.3	49.4	43.8	303.7
Phos. 2 parts SM 1 part	L. S. U.	81.8	375.2	37.9	18.9	513.8
Phos. 2 parts SM 1 part 4%K	L. S. U.	94.3	373.2	35.1	20.1	522.7
Phos. 3 parts SM 2 parts	L. S. U	92.7	369.5	36.0	19.1	517.3
Phos. 2 parts CSM 1 part	L. S. U.	77.1	357.7	40.5	20.4	495.7
Phos. 2 parts CSM 1 part 4%K.	L. S. U.	81.0	327.2	36.0	21.4	465.6
NPK 4–8–4	L. S. U.	94.0	386.7	39.3	22.6	542.6
Check	L. S. U.	54.3	337.7	38.1	18.8	444.9

TABLE 8. SPACING TEST—THREE-YEAR AVERAGE

Distance Apart in the Row	YIELD IN BUSHELS PER ACRE				*Total Yield*
	Jumbos	*No. 1s*	*No. 2s*	*Culls*	
9 inches	32.1	338.4	33.6	26.9	431.0
12 inches	41.2	373.6	36.3	25.4	476.5
15 inches	34.5	357.5	35.2	23.2	450.4
18 inches	62.8	319.6	28.0	20.8	431.2
21 inches	59.3	308.0	27.9	17.6	412.8

TABLE 9. EFFECT OF PLANTING DATE ON TOTAL YIELD OF SWEET POTATOES

Planting Date	*Date of Harvest*	*Total Yield in Bushels per Acre*
May 15	October 24	686.1
June 10	November 15	458.1
July 23	November 19	259.2

eration in growing sweet potatoes. If this crop is grown commercially, the yield of No. 1 potatoes is most important, and often the yield of fancy No. 1s determines the return from the crop. It has been found at the Louisiana Agricultural Experiment Station that the planting date affects the shape as well as the size of sweet potatoes. In general, the earlier the plants are set out, the heavier is the yield of jumbo potatoes. The effect of planting date on the shape of potatoes is shown in Fig. 2 and Table 10. The earlier the plants were set the greater was the percentage of flat, turnip-shaped potatoes produced. The later the planting, the longer and narrower were the potatoes. The range in shape of early and late planted potatoes is shown in Table 10.

TABLE 10. EFFECTS OF DATE OF PLANTING ON THE SHAPE OF SWEET POTATOES

Time of Planting	*L/D Ratio*	*Average Length (Cm)*	*Average Diameter (Cm)*
Early, May 6, 1932..............	1.57 ±0.014	12.14	7.74
Late, July 15, 1932..............	2.78 ±0.024	17.15	6.16
Early, April 20, 1933.............	1.33 ±0.023	10.72	8.06
Late, June 15, 1933..............	2.23 ±0.039	13.79	6.18

As earlier plantings are usualy made with slips and later ones with vine cuttings, it might be supposed that this would influence the shape of potatoes produced. That this is not true is shown in Table 11.

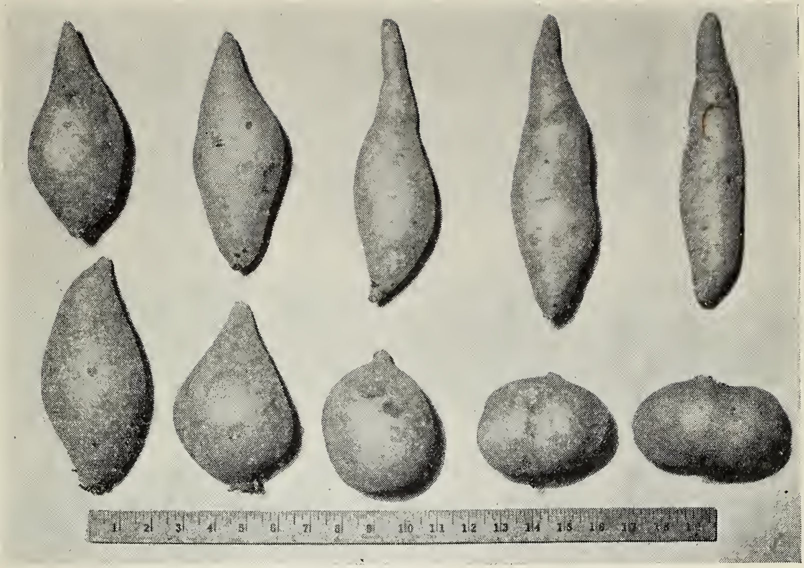

Fig.2. Lower row—potatoes from early planted lot. Upper row—potatoes from late planted lot.

TABLE 11. COMPARISONS OF SHAPE OF SWEET POTATOES PRODUCED FROM SLIPS AND VINE CUTTINGS

Time of Planting	POTATOES FROM SLIPS		POTATOES FROM VINE CUTTINGS	
	Number of Potatoes Measured	*L/D Ratio*	*Number of Potatoes Measured*	*L/D Ratio*
Early	564	1.33	565	1.33
Late	209	2.26	294	2.21

The best type of potato for market is neither too flat nor too slender. Those pictured at the left in Fig. 2 are the most desirable shape. In south Louisiana, the first part of June is the most favorable time for planting to produce potatoes of this shape.

If potatoes are grown for starch manufacture, total yield is of primary importance, therefore early planting should be practiced.

Sweet potato slips or vine cuttings live easily if conditions are favorable at planting time. It is best to set slips or cuttings during rainy spells, or during periods of cloudy weather if the soil is damp. Late afternoon is the best planting time, especially under unfavorable conditions. Watering at planting time will usually insure the life of the plant except during periods of excessively dry, hot weather. The soil should be firmed around the slip or cutting when it is set. A sweet potato cutting should be 15 to 18 inches in length.

CULTIVATION

Sweet potatoes require relatively little cultivation. About two shallow cultivations should be sufficient to control weeds and grass until the vines cover the ground, after which they will usually take care of themselves. If weeds and grass are not held in check until the vines get well started, they may choke out the potato vines.

CLIMATE

Sweet potatoes thrive best where the growing season is long and warm. After plants are well established they can withstand periods of drouth successfully. Sweet potatoes are more productive in dry seasons than in wet ones. If there is too much rain, excessive vine growth is produced and the potato yield reduced. Potatoes of best quality are produced in dry seasons.

HARVESTING

Maturity of sweet potatoes is a relative term. A sweet potato that weighed approximately 125 pounds was exhibited at the St. Louis Exposition in 1905. This potato was from a plant set by Dr. Stubbs in a greenhouse in Audubon Park, New Orleans, Louisiana, and allowed to grow for several years. A sweet potato, then, does not mature in one growing season, but growth is stopped by digging, disease, frost, or other factors.

The time of digging potatoes will depend somewhat upon marketing. If potatoes are grown for the early market, they should be dug when the yield obtained is high enough to insure a profit at the market price. In general, the earliest potatoes bring the highest price on the early market. However, the increase in yield of potatoes dug later may more than compensate for the decrease in price. It is not desirable to hold over for late digging and storage those potatoes which were planted early for early digging. This is because many may rot in the ground; there may be too many of the jumbo size; the shape may not be as desirable; and they do not seem to keep as well in storage. By digging a part of a row, the grower may determine the type of potatoes present in a field. The early crop of potatoes is usually marketed in July and August.

The main crop of potatoes is dug in the fall. The yield of No. 1 potatoes present in the field will indicate when the potatoes may be dug. Sweet potatoes should be dug before the vines are killed by frost. If they are allowed to stay in the field a few days after a killing frost, their storage and eating qualities will be markedly impaired. It is best to dig sweet potatoes during dry warm weather. In the commercial sweet potato section of Louisiana, the month of October is the best time for harvesting. This is usually a comparatively warm, dry month and potatoes will be dug before danger of a killing frost.

When vine growth is heavy, vines should be cut before the potatoes are plowed out. Various methods are used for plowing out potatoes, but none is especially satisfactory. Care is necessary in this operation to prevent cutting. When heavy yields are obtained, it is necessary to plow two furrows. The first one will cut off about one-third of the row and the other will throw out most of the potatoes.

The potatoes should not be thrown together in heap rows as this will cause excessive bruising. Freshly dug potatoes bruise very easily and if bruised, they will not keep well in storage. It is best to grade the potatoes in the field. U. S. 1s should be carefully placed in crates and taken directly to the storage house. No. 2s may be stored. Jumbos and culls should be used for feed. Storage crates are usually of heavier construction than shipping crates and may be used for several years. The necessity for care in handling sweet potatoes at harvest time cannot be overemphasized. Those that are to be stored or shipped should be handled as little as possible.

Curing

Proper curing immediately after digging is thought to be one of the requisites of success in storing sweet potatoes. Potatoes which are being cured should be kept at a temperature of from 80° to 85° F. for 10 to 20 days, depending upon their dryness at digging time and upon weather conditions. Artificial heat is generally thought to be essential to maintain the proper temperature during the curing period. During this time there may be a shrinkage of 5 to 6 per cent when no rot is present. Early investigators thought that curing was important to remove excess moisture from the potatoes and that it was largely a drying process. When it was found that the moisture content might vary little from digging time until after curing, loss of solids seemed to be important. Experiments were run to determine what part of the shrinkage during curing was due to loss of solids and what part to loss of moisture. By measuring the carbon dioxide of respiration during the curing period, it was found that solids to the extent of approximately 1 per cent of the original fresh weight were lost during the curing period. This means that while shrinkage during curing is largely loss of moisture, the loss of solids is not a negligible factor. The shrinkage is loss to the producer, since the consumer gets a little higher food value per unit of potatoes after they are cured than he would before curing. A greater shrinkage during curing occurs in potatoes having the higher moisture contents at digging time. Some potatoes may have higher moisture contents after curing than do others immediately after digging. This indicates that moisture relationships are not the only important ones in curing. Workers in the United States Department of Agriculture have found that conditions recommended for curing sweet potatoes are ideal for healing of wounds. As all sweet potatoes when dug have wounds that must heal to offer resistance to rot organisms, the healing of wounds may be the most important thing accomplished by curing.

Just what is meant by a cured potato is rather indefinite. Tests to determine whether or not a potato is cured are often given, but no reliable test is known to tell when the curing period is over.

At digging time sweet potatoes are, in general, low in sugar content. During the curing period, a part of the starch changes to sugar and the percentage of sugar increases, in spite of the high rate of respiration at curing temperatures. This increase in sugar content continues for a time during storage. This explains why sweet potatoes are not as good immediately after digging as they are after curing and a period of storage.

Storage

Since there are available bulletins on the subject of sweet potato storage houses, it is unnecessary to describe them, other than to say that they should be well insulated and well ventilated.

After they are cured, sweet potatoes should be stored at temperatures ranging from 50° to 60° F. The relative humidity should be such that no moisture accumulates on the walls, crates, or potatoes. At temperatures below 50° F. sugar accumulates more rapidly than it does at higher temperatures, but the potatoes will not keep for any length of time. Workers in the United States Department of Agriculture have found that sweet potatoes are especially susceptible to rot injury at temperatures below 50° F. This probably explains why they will not keep at lower temperatures. Exposure of potatoes to temperatures below 50° F. and above the freezing point for short intervals may not be injurious, but unnecessary risks should not be taken.

It is best to store sweet potatoes in crates and not handle them from the time they are placed in storage until they are removed for use. It is possible to keep potatoes in bulk in bins, but if this is done the bins should be no more than 3 feet wide by 8 feet deep, and the potatoes not more than 6 to 7 feet deep in the bin. In any case, provision must be made for good air circulation around the stored potatoes. A space of four inches should be left between bins for ventilation. Rats and mice should be kept out of the storage house as they injure potatoes and spread rot.

Sweet potatoes are stored to some extent in banks or mounds. This is not a reliable method of storage and should be used only for potatoes to be used at home, when no suitable place in a building is available. Potatoes to be shipped should never be kept in bank storage.

In south Louisiana the temperature during the month of October is comparatively high and that month is usually dry. Curing with artificial heat is not generally practiced in this section, even in the commercially important Sunset district. Experiments were run to compare sweet potatoes cured and stored in a storage house where artificial heat was used with those kept in a building that could be given good ventilation but was not artificially heated. Potatoes of the Porto Rico variety that were planted and dug at different times were used. Moisture determinations were made at time of harvest, after curing, and at intervals during the storage period to determine the effects of the treatments used on the moisture content of the potatoes. Twelve one-bushel crates of sweet potatoes were used for each treatment. Shrinkage during curing and for the storage period and loss due to rot were determined.

The results of this test are shown in Table 12. These data show that there was little difference in the keeping of potatoes due to storage treatment. During the curing period, the shinkage was slightly less in the artificially heated lots which were planted and dug earlier; the reverse was true in the case of those planted and dug later. Curing conditions when no artificial heat was used were not as favorable for the later dug lots as they were for those dug earlier in the season. Total shrinkage for the storage season was about the same in both types of storage used. There was no consistent difference in amount of rot in comparable lots stored under the different conditions. There was a higher percentage of rotten potatoes in the lots which were planted earlier and dug earlier than in the lots which were planted and dug later. The shorter storage period might account for this, but there was some indication that the shape of the potatoes affected their keeping qualities, since the chunkier ones did not keep so well.

Variations in moisture content are shown in Table 13. This varied considerably from season to season and with the time of digging during a given season. In general, the moisture content was lower in the potatoes which were planted and

TABLE 12. SHRINKAGE AND LOSS FROM ROT IN SWEET POTATOES CURED AND STORED WHERE ARTIFICIAL HEAT WAS USED COMPARED WITH THAT IN THOSE WHERE NO ARTIFICIAL HEAT WAS USED

Year	*Date of Harvest*	*Treatment*	*Shrinkage During Curing Per cent*	*Shrinkage for Storage Period. Per cent*	*Length of Storage Period*		*Loss from Rot at End of Storage Season. Per cent*
					Mos.	*Days*	
1930–1931	Nov 7	Artificial heat..........		14.00	4		.56
		No artificial heat.......		13.90			.43
1931–1932	Oct. 22	Artificial heat..........	6.14	15.04	4	11	11.53
		No artificial heat.......	6.93	14.50			11.60
	Dec. 7	Artificial heat..........	5.71	9.77	2	27	.46
		No artificial heat.......	3.16	9.48			2.96
1933–1934	Oct. 10	Artificial heat..........	4.53	10.86	4		6.76
		No artificial heat.......	4.80	11.79			7.26
	Nov. 2	Artificial heat..........	6.52	11.68	3	10	4.44
		No artificial heat.......	4.41	10.62			1.15
1934–1935	Oct. 26	Artificial heat..........	6.23	11.82	3	10	2.00
		No artificial heat.......	6.97	12.08			2.79
	Nov. 17	Artificial heat..........	4.87	10.03	2	18	2.55
		No artificial heat.......	3.61	8.52			1.50

dug later. Changes in moisture content during curing varied with the moisture present in the potatoes at digging time, reductions, in general, being greater when higher percentages were present at the time curing was started. There was very little difference in moisture content and variations were not consistent between potatoes which received artificial heat and those which did not. In general, change in moisture content after the curing period was not appreciable. After the curing period no consistent differences due to storage treatment were found in moisture contents of potatoes. The data also show that the moisture in some lots of potatoes at digging time was lower than in others after the curing period.

It is possible to successfully cure and store sweet potatoes in south Louisiana, and probably throughout the far South, without artificial heat. In the Sunset area, large quantities of sweet potatoes are stored in warehouse-like buildings. The potatoes themselves seem to furnish sufficient warmth during cold spells to render artificial heating unnecessary during the storage period. Most of the crop is dug during the month of October.

MARKETING

The most important factors to be considered in marketing a crop successfully are (1) to produce a product that the consumers want; (2) to prepare the product for sale in an attractive manner, which means that it must be clean and well graded; and (3) to maintain a constant supply throughout the year. If Louisiana is to hold her high position in the market, these factors must be kept in mind constantly.

TABLE 13. COMPARISON OF MOISTURE CONTENTS OF SWEET POTATOES CURED AND STORED WITH AND WITHOUT ARTIFICIAL HEAT

Year	*Date of Harvest*	*Treatment*	*Moisture Content Per cent*			*Date Removed from Storage*
			At Digging Time	*After Curing Period*	*At End of Storage Period*	
1930	Nov. 5	Artificial heat...........	74.04	72.21	71.33	April 9
		No artificial heat........		71.66	71.99	
	Nov. 8	Artificial heat...........	73.85	71.83	70.88	April 9
		No artificial heat........		71.66	71.61	
1931	Oct. 22	Artificial heat...........	72.35	70.38	70.72	March 4
		No artificial heat........		71.24	70.71	
	Dec. 7	Artificial heat...........	71.31	70.18	68.41	March 4
		No artificial heat........		69.16	70.64	
1932	Oct. 13	Artificial heat...........	74.99	71.51	70.83	Feb. 27
		No artificial heat........		70.59		
	Nov. 10	Artificial heat...........	71.67	70.21	68.10	Feb. 27
		No artificial heat........		69.30	69.71	
1933	Oct. 10	Artificial heat...........	72.70	71.66	72.76	Feb 14
		No artificial heat........		71.64	72.48	
	Nov. 2	Artificial heat...........	67.62	67.58	69.96	Feb. 14
		No artificial heat........		68.37	67.78	
1934	Oct. 26	Artificial heat...........	72.06	72.01	70.96	Feb. 5
		No artificial heat........		72.03	71.21	
	Nov. 17	Artificial heat...........	70.01	67.94	68.09	Feb. 5
		No artificial heat........		67.96	69.27	

GRADING AND PACKING

Since sweet potatoes must be handled carefully and as few times as possible, the most convenient place for preliminary grading is in the field at harvest time. At this time the grades U. S. Fancy, U. S. No. 1, and U. S. No. 2 should be placed in field crates, which are then hauled to the packing shed or to the storage house, depending upon season and marketing period.

There are two distinct methods used in Louisiana for preparing sweet potatoes for market. First: the freshly harvested potatoes are delivered to the packing shed where they are washed, given a final grading, and packed carefully in a lengthwise position in the shipping crate. Washing the potatoes is practiced from July 15, when the harvesting of the new crop begins, until about the last of October. At this time the shipments of cured potatoes start and the second method of cleaning is used. After curing, the potatoes are cleaned with burlap brushes for shipment. The brush is made from about one-fourth square yard of burlap material, usually from old sacks, by bringing the corners together and folding the center or middle portion to make a handle which is bound tightly with wire or strong cord. With such a cleaner, the packers make two or three strokes, turning the potato at each pass of the brush. In this manner, the potatoes are brushed free of soil and present a clean, attractive appearance. As previously mentioned, they are placed in the shipping crates by hand. The cleaners and packers should wear cloth gloves to prevent scratching or bruising the potatoes with the fingernails.

Most of the potatoes shipped from Louisiana are packed in one-bushel wire-bound crates which are usually lined with a bright colored paper. It is the usual practice to ship only potatoes grading U. S. Fancy and U. S. No. 1. When there is a scarcity, however, some U. S. No. 2s are shipped. The No. 2 grade is sold to local markets and to truckers who haul them to markets of intermediate distance. These potatoes are usually packed in 100-pound sacks and the end of the sack is sewed to expose them to view.

GRADES

Following are the grades and descriptions for sweet potatoes as formulated by the Bureau of Agricultural Economics of the United States Department of Agriculture:

> *U. S. No. 1* shall consist of sweet potatoes of similar varietal characteristics which are firm, not badly misshapen; which are free from black rot, decay, and freezing injury; and free from damage caused by dirt, secondary rootlets, bruises, cuts, scars, growth cracks, scald, scurf or other diseases, weevils or other insects, and mechanical or other means.
>
> *Unless Otherwise Specified,* the diameter of each sweet potato shall not be less than 1¾ inches nor more than 3½ inches, and the length shall not be less than 3 inches nor more than 10 inches, but the length may be less than 3 inches if the diameter is 2 inches or more.
>
> *Tolerances.* In order to allow for variations other than size, incident to proper grading and handling, not more than 10 per cent, by weight, of the sweet potatoes in any lot may be below the requirements of this grade, but not to exceed a total of 5 per cent, shall be allowed for defects causing serious damage, and not more than 1/5 of this amount, or 1 per cent, shall be allowed for sweet potatoes affected with soft rot.
>
> In addition, not more than 10 per cent, by weight, of the sweet potatoes in any lot may not meet the size requirements, but not more than one-half of this tolerance, or 5 per cent, shall be allowed for sweet potatoes which are below the minimum size requirements.
>
> *U. S. No.* 2 shall consist of sweet potatoes of similar varietal characteristics which are firm and which are free from black rot, decay, and freezing injury; and free from serious damage caused by dirt, bruises, cuts, scars, growth cracks, scald, disease, weevils or other insects and mechanical or other means.
>
> *Unless Otherwise Specified,* the diameter of each sweet potato shall not be less than 1½ inches nor more than 4 inches.
>
> *Tolerances.* In order to allow for variations other than size, incident to proper grading and handling, not more than 10 per cent, by weight, of the sweet potatoes in any lot may be below the requirements of this grade, but not to exceed 1/10 of this amount, or 1 per cent, shall be allowed for sweet potatoes affected with soft rot.
>
> In addition, not more than 10 per cent, by weight, of the sweet potatoes in any lot may not meet the size requirements, but not more than one-half of this tolerance, or 5 per cent, shall be allowed for sweet potatoes which are below the minimum size requirements.

U. S. Fancy shall consist of sweet potatoes of similar varietal characteristics which are firm, smooth, and well shaped; which are free from black rot, decay, and freezing injury; and free from damage caused by dirt, secondary rootlets, bruises, cuts, scars, growth cracks, scald, scurf or other disease, weevils, or other insects and mechanical or other means.

The diameter of each sweet potato shall not be less than 2 inches or more than 3½ inches and the length shall not be less than 3 inches nor more than 6 inches, but the length may be less than 3 inches if the diameter is 2¼ inches or more.

Tolerances. In order to allow for variations other than size incident to proper grading and handling, not more than 10 per cent, by weight, of the sweet potatoes in any lot may be below the requirements of this grade, but not to exceed a total of 3 per cent, shall be allowed for defects causing serious damage, and not more than 1/3 of this amount, or 1 per cent, shall be allowed for sweet potatoes affected with soft rot.

In addition, not more than 10 per cent, by weight, of the sweet potatoes in any lot may not meet the size requirements, but not more than one-half of this tolerance, or 5 per cent, shall be allowed for sweet potatoes which are below the minimum size requirements.

Unclassified shall consist of sweet potatoes which are not graded in conformity with any of the foregoing grades.

SELLING AND DISTRIBUTION

Marketing of the Louisiana sweet potato crop is entirely in the hands of local dealers, who in many cases are also large growers. They market their own crops and buy potatoes from other growers or represent a number of growers in what is termed an association. There are few strictly cooperative associations. The dealers, however, make every effort to market the potatoes advantageously. Through the present marketing organizations, sweet potatoes of the best grade are marketed twelve months in the year. Each season finds new markets buying Louisiana Porto Rico sweet potatoes in such quantities that this state now leads all others in car shipments of this important crop.

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Diseases of Tung Trees In Louisiana

BY

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Diseases of Tung Trees In Louisiana

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INTRODUCTION

Extensive plantings of tung trees have been made in Louisiana during the last few years. There are at present (1936) between three and four thousand acres of tung groves in the state and probably more than a thousand acres of land are now being prepared for additional plantings in 1937.

At present there is very little definite information regarding the adaptability of the tung tree to the various Louisiana soils or its resistance to the attack of various plant diseases and insect pests. This information should be obtained as rapidly as possible to protect growers from the serious troubles which are likely to develop as trees become older and plantings more extensive.

During the past two years the Department of Plant Pathology of the Louisiana Agricultural Experiment Station has made a preliminary survey of the diseases affecting tung trees in Louisiana. Several diseases were found which are being described under the following names: (a) bacterial leaf spot; (b) nut rot; (c) branch and twig cankers; (d) crown girdle; (e) intervenal browning of leaves; (f) translucent spot on leaves; and (g) "white tree." Besides these, several other diseases, including one known as the bronzing disease of the foliage, are known to occur in other parts of the South. While some of these troubles will undoubtedly remain insignificant, others may become important.

The information now available concerning these diseases is presented in this bulletin.

BACTERIAL LEAF SPOT

The bacterial leaf spot disease of the tung tree was first reported from Georgia by Boyd (1) in 1930. Later, McCullough and Demaree (3) described the causal agent (*Bacterium aleuritides*) and proved its pathogenicity by artificial inoculations.

The disease is characterized by spotting of the leaves (Fig. 1). The spots are angular in shape, dark brown to nearly black in color on the upper surface and light brown on the under surface. The center of the spot is usually lighter in color than the border. The spots, especially the young ones, are surrounded by a rather wide, yellowish halo. Coalescence of the spots may occur, forming large areas of dead tissue.

The bacterial leaf spot was found in the vicinity of Bogalusa, Louisiana, in September, 1935. The infection in the groves examined was general but light, and the damage caused would be termed very slight. The disease was not found in 1936.

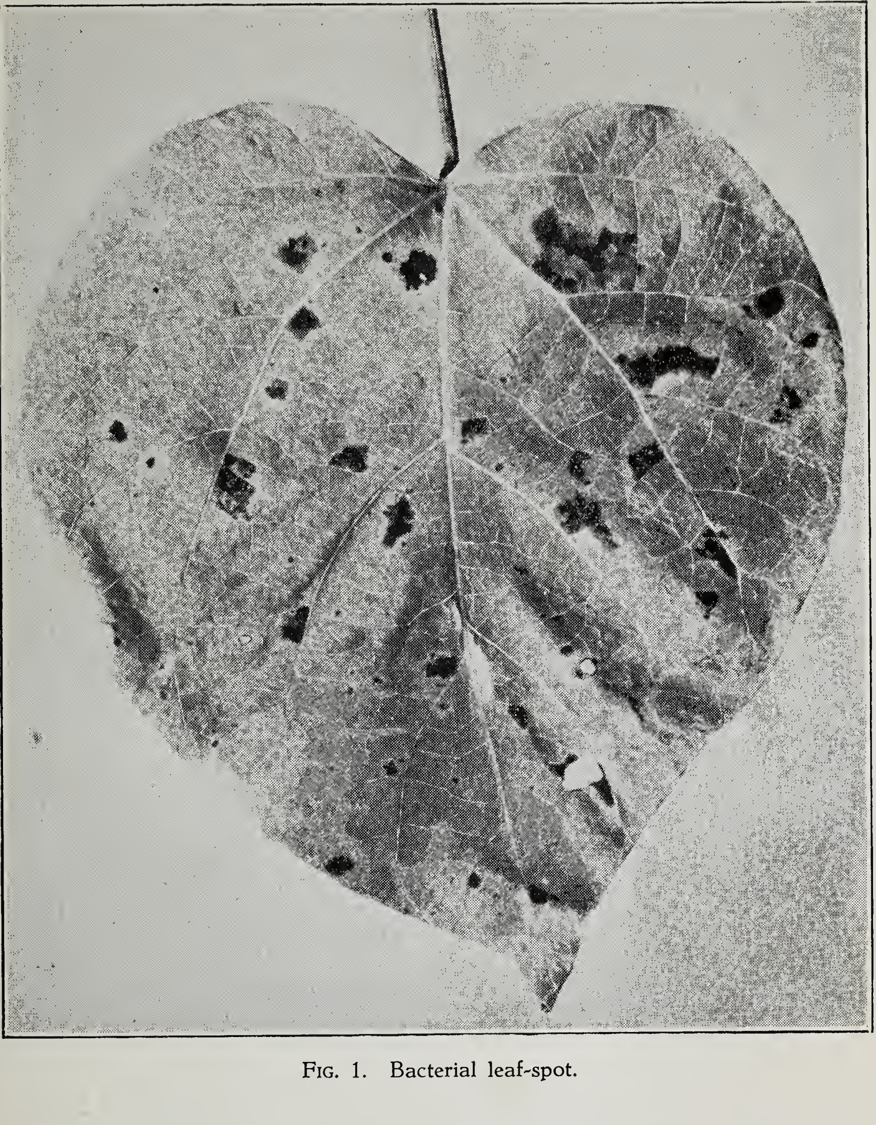

Fig. 1. Bacterial leaf-spot.

NUT ROT

The nut rot disease affects the fruit of the tung tree (Fig. 2). The husk dries and turns brown in color and the nut may drop prematurely or may remain hanging on the tree in the form of a mummy. The surface of the affected nut is covered with minute pimple-like pustules which are the fruiting bodies of pycnidia of the fungus *Dothiorella* (probably *D. ribis*=*Botryosphaeria ribis* Gros. & Dug.), which undoubtedly causes the rot. The mycelium of the fungus penetrates all the husk layers

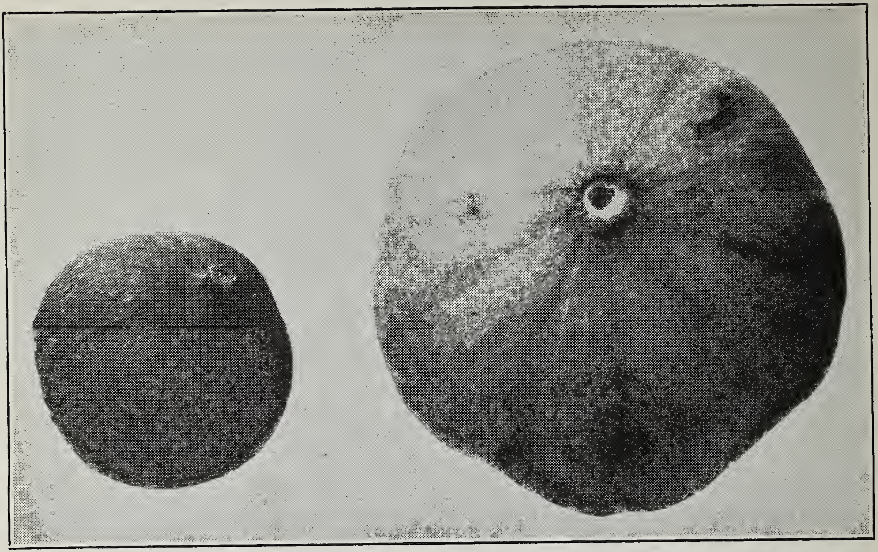

FIG. 2 Nut rot disease. Left: Affected with nut rot. Right: Healthy mature nut.

and often is found within the hard shell. The pedical is also invaded and killed. The fungus can easily be isolated either from conidia or from the husk tissue.

This disease was found to be serious in some groves. In one grove examined on September 30, 1935, it was not uncommon to find 25 per cent of the nuts hanging mummified on some trees, with many more on the ground. The same grove was visited again on September 29, 1936, and the disease was again found to be very prevalent. Counts were made of normal and affected nuts on four consecutive trees in a row, and the figures obtained are shown in Table 1. These results are interesting because they illustrate the seriousness of the disease in this particular grove and especially because they seem to indicate individual variability in resistance or susceptibility between different trees. Since the trees are seedlings and vary individually in many morphological characteristics, it is logical to expect variations in resistance to disease as well.

TABLE 1. *Dothiorella* Rot of Tung Nuts. Counts of Sound and Affected Nuts on Four Consecutive Trees in a Row.
Isabel, Louisiana, September 29, 1936

TREE NO.	SOUND NUTS	AFFECTED NUTS On Tree	AFFECTED NUTS On Ground	PERCENTAGE OF NUTS AFFECTED
1	31	47	52	76.1
2	35	6	37	89.6
3	36	1	13	28.0
4	68	2	12	17.4

It should be made clear that the actual loss to the crop is lower than the figures presented in Table 1 would indicate, because all of the affected nuts are not worthless. If the nut becomes infected early in its growth it either fails to fill or the kernel shrivels badly; however, if the infection occurs later, the nut fills and matures more or less normally, although it may be smaller in size than the normal nut.

Considerable variation was also noted in the amount of infection in different groves. In some groves very little nut rot was found, while in others the amount of affected nuts was very high. The disease was found to be much more prevalent in groves growing on poor soils. Whether this was mere coincidence or whether it means that soil fertility influences the development of the disease has not been determined.

BRANCH AND TWIG CANKER

Branch and twig cankers of two types were found on tung trees: (a) those occurring on older branches, and (b) those occurring on young shoots (current season's and previous year's growth). The fungus *Dothiorella* (*Botryosphaeria*) sp. was found constantly associated with both types of canker.

In the case of the cankers on older branches, the fungus appears to be a secondary invader of wounds caused by some other agent, such as freezing. This type of canker is shown in Figure 3, B. The branch was injured by freezing in the winter of 1934-1935 and a small bark canker about six inches in length resulted. Later in the summer a fresh canker developed, spreading for about 26 inches above and for about 18 inches below the original freeze-injury canker, and eventually girdled and killed the branch. The *Dothiorella* fungus was easily isolated from the freshly killed bark.

The cankers on the young shoots do not appear to be associated with previous injury. In late summer affected shoots may be seen from a distance, for when the bark is killed the leaves wilt first, then dry up and remain hanging on the twig. Close examination shows very numerous pustules, the pycnida of *Dothiorella,* on the killed bark. Pieces of freshly-killed bark were plated, and cultures of *Dothiorella* were obtained invariably. The killing of the bark is apparently very rapid, for a canker may be from two to three feet long before the infection on the shoot is noted, that is, by the time the leaves begin to wilt. There is no evidence of wound or mechanical injury through which the fungus gains entrance into the bark. Also, no correlation between infection and the position of the shoot on the tree has been noted. Affected shoots were seen both on the very top of trees and on lower branches. The damage caused by these branch and shoot cankers is of relatively minor importance.

CROWN GIRDLE

The crown girdle of the tung tree is apparently the same as that affecting the pear tree in Louisiana (7).

Symptoms: An infected tree makes a good growth in the spring and early summer and sets a normal crop of fruit. The first indications that a tree is affected are yellowing and wilting of the foliage, which usually occur in late summer. Examination of trees showing these foliage symptoms reveals that the bark and cambium of the trunk at the crown has been killed (Fig. 3, A). A canker extends above the ground line usually from 8 to 10 inches and sometimes higher, and below the ground to the main roots. In the early stages the roots are sound; later the main roots also become affected. This indicates that the canker starts at or near the ground line and spreads upward and downward. The sapwood under the killed bark is usually discolored, and often, though not always, the central cylinder of the trunk (the pith and surrounding wood, 1 to 2 inches in diameter) is brown in color and apparently dead, but not decayed. This discolored central cylinder may extend for several feet above the canker, but there is no visible connection between it and the discolored sapwood of the canker. Usually plaques of white mycelium occur between the killed

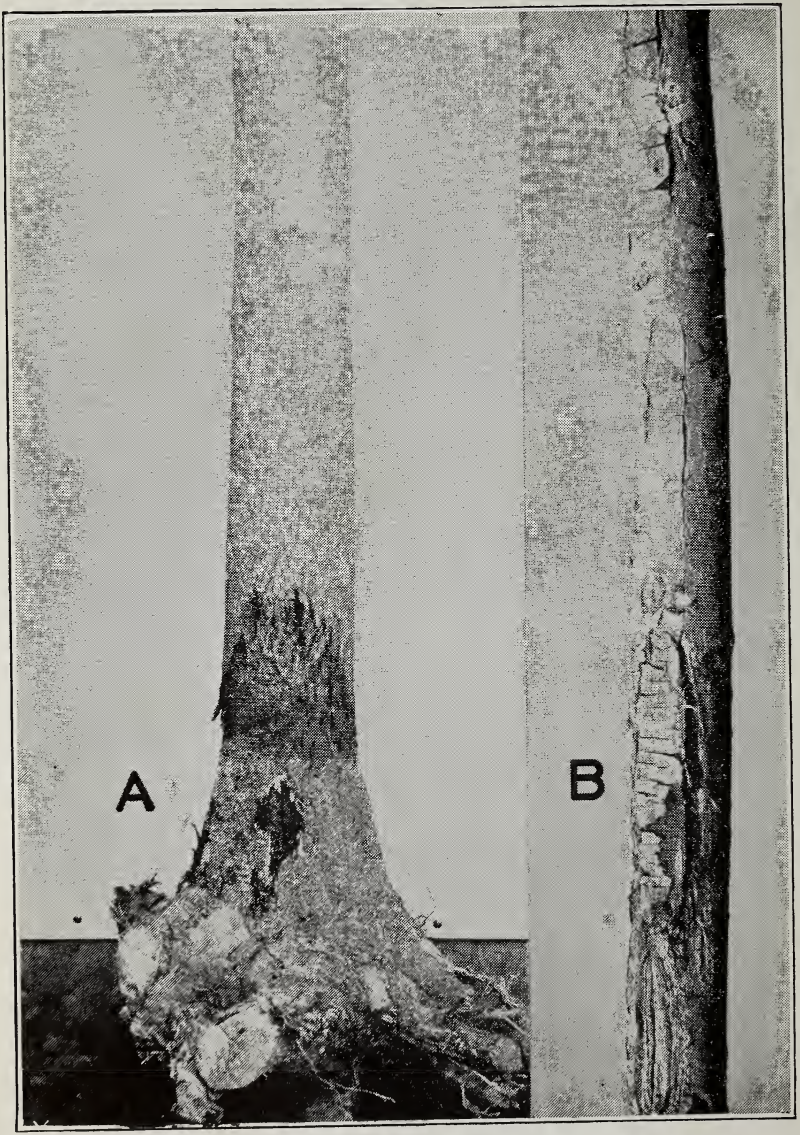

Fig. 3. A. Tree killed by the crown girdle disease. B. *Dothiorella* canker on branch.

bark and the underlying wood and between the layers of the bark. Trees of different ages, from 1 to 8 years old, have been found affected.

Cause: The cause of this disease is not known. Some of its symptoms suggest winter killing, although certain other symptoms indicate that cold injury is probably not the sole cause of the trouble. In southern Louisiana the ground does not freeze to any depth, so no killing of the bark below the ground should occur, yet the cankers extend from 8 to 10 inches below ground and it is often apparent from the condition of a canker that the injury started below ground. Also, the upper margin of the canker is still active, often as late as September, with no callus formation separating the killed from the living bark.

Repeated platings from cankers have shown that a fungus, *Dothiorella* (Botryosphaeria) sp., is constantly associated with this disease. Over 75 per cent of the isolations made were of this fungus. Other fungi isolated with more or less constancy were *Cephalosporium* sp., *Diplodia* sp., and *Clitocybe* sp. As previously reported (7), the *Dothiorella* fungus was found to be pathogenic to pear trees when inoculated into the bark, producing cankers on the trunks that are similar in appearance to those occurring on naturally affected trees in the earlier stages of the disease. No inoculation tests have been made on tung trees.

It is probable that cold injury initiates the trouble, and that fungi, gaining entrance through the injured tissue, invade the sound bark and kill the tree by ringing the trunk. The chief obstacle in determining the causal organism lies in the fact that the disease is not observed until the tree begins to wilt and die, and by then the killed tissues have been invaded by many secondary organisms. No evidence has been obtained to indicate that any one of the fungi isolated is the primary cause of the disease.

This disease apparently is not limited to Louisiana. Miller (4) recently reported seeing numerous dead or dying tung trees in commercial plantings of south Mississippi. From his brief description of the symptoms on these trees it is apparent that the disease he noted is the same as that reported here. A trouble which is similar or identical has also been reported from Texas (2).

Economic Importance: Since the affected tree is killed, the disease is serious as far as individual trees are concerned. As yet only a few trees have been found dead or dying from this trouble, and it is estimated that probably no more than 0.5 per cent of the trees in Louisiana are so affected.

INTERVENAL BROWNING

A peculiar browning of tung leaves, characterized by brown spots which occur in more or less regular arrangement between the larger veins (Fig. 4), is rather common in Louisiana. For this trouble the term "intervenal browning" is suggested. A mild form and a severe form of this peculiar trouble have been noted. In the mild form the browning is limited to the upper leaf surface (epidermis and palisade cells), the lower surface of the affected leaf appearing normal. In the severe form the browning extends to the lower leaf surface, and, in the older spots at least, the brown tissue is necrotic. As far as has been observed, there is very little merging of the two forms. Usually, a tree will show either the mild or the severe form, seldom both.

Microscopic examination of the diseased material failed to show any organisms present, and plating of the affected tissue did not give rise to any bacterial or fungus growth. The rather regular pattern and uniform location of the spots (always intervenally) suggest that the trouble is non-parasitic. In addition, the fact that the

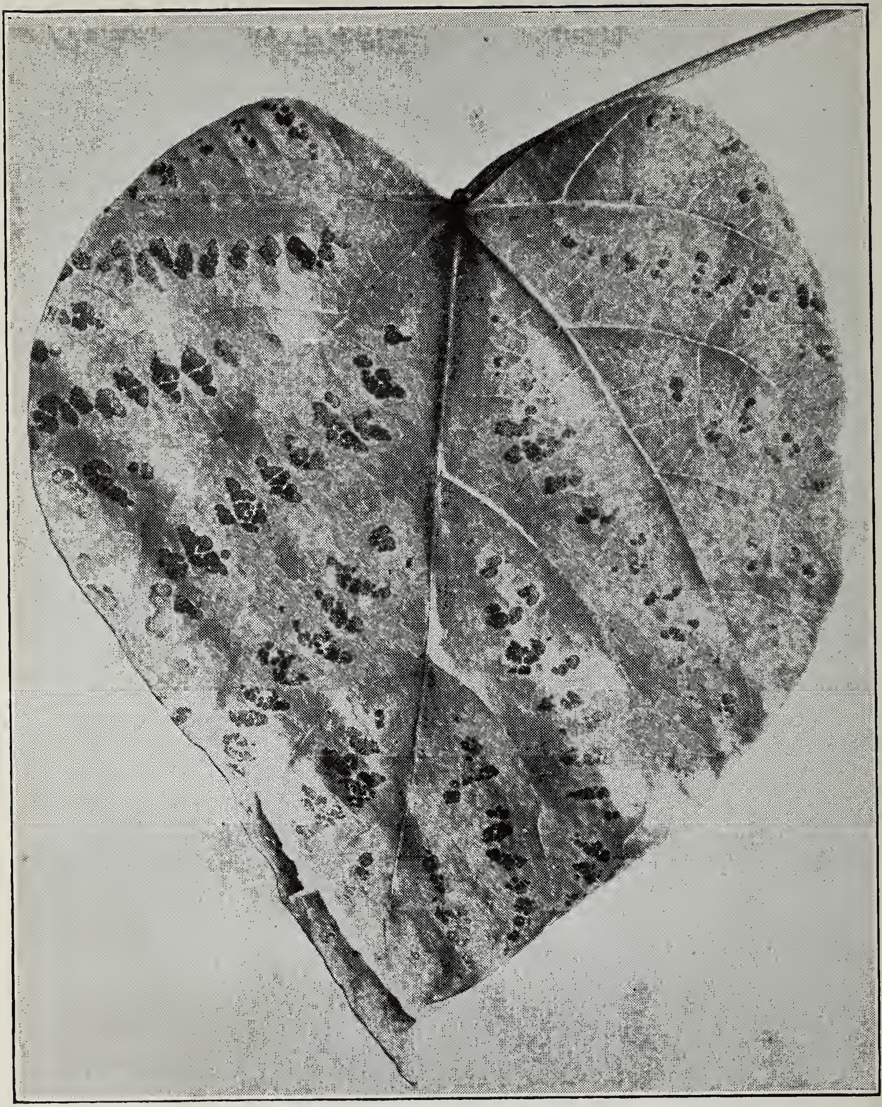

FIG. 4. Intervenal browning.

disease is limited to certain trees (one tree may show considerable spotting, while the neighboring trees may not show any) suggests that it is of a non-parasitic nature. The trouble was found to be very prevalent in a grove on poor soil, suggesting a nutritional deficiency of some sort as the cause. However, it was found to be equally prevalent in the fertilizer test plats in the same grove on trees which had received varying amounts of complete fertilizer during the last three years, so it is evident that it is not due to a deficiency of any of the common plant food elements.

This trouble is of minor economic importance. While there is no doubt that some damage is caused by this disease because the spotting considerably reduces the effective leaf area, trees so affected show no noticeable stunting of growth and have matured good crops of nuts.

TRANSLUCENT SPOT

For a second peculiar abnormality of the leaves the name "translucent" spot is suggested. Specimens showing this peculiar spotting were sent to this laboratory in November, 1934, from trees growing in the vicinity of Baton Rouge; then it was found on several trees near Bogalusa in September, 1935, and again in 1936.

In the early stages the disease appears as a roughening on the under epidermis of the leaves. The spots first appear as irregular patches, ashen-gray in color and somewhat raised, but soon may coalesce and cover approximately 90 per cent of the under leaf surface (Fig. 5). In the early stages the spotting is not visible on the upper leaf surface by reflected light; however, if the leaf is held against the light, the outlines of the spots can be seen—hence the term "translucent" spot. In the later stages minute brown spots (at first pin-point in size, but later enlarging somewhat) appear. These are visible on the upper surface. These brown necrotic spots appear to start on the lower leaf surface and spread gradually until they reach the upper surface, for the necrotic areas are larger on the lower than on the upper leaf surface.

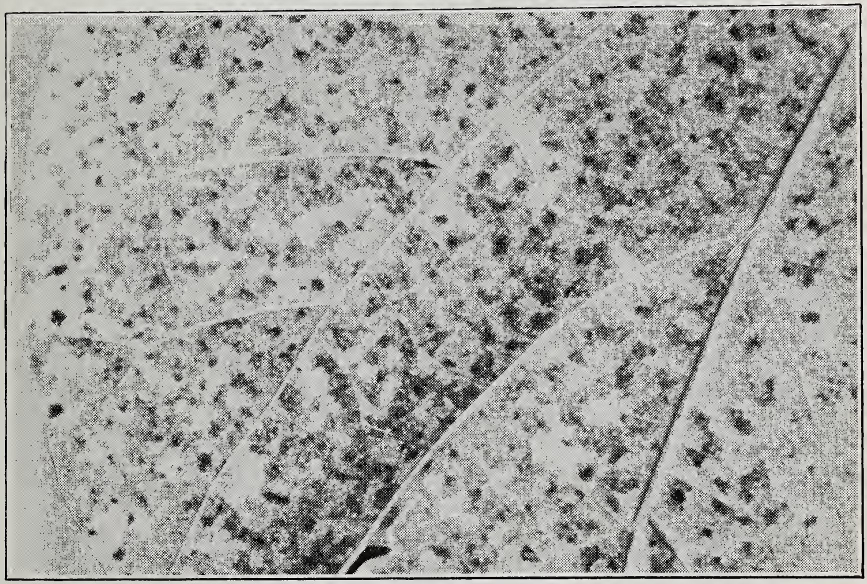

FIG. 5. Translucent spot.

Sections of affected leaves (both free-hand sections of fresh material and fixed and stained material) exhibit striking abnormalities. There is a hypertrophy of the spongy parenchyma cells (and occasionally of the palisades). The spongy parenchyma cells enlarge several times their normal size, pressing against each other until there are no

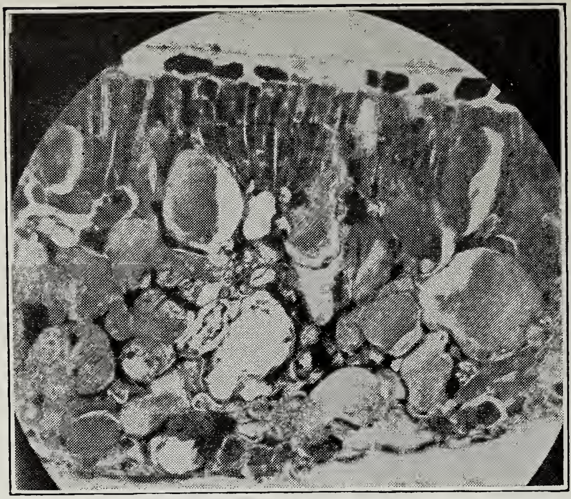

FIG. 6. Section of leaf affected with the translucent spot showing both hypertrophy and necrosis of spongy parenchyma cells.

intercellular spaces left (Fig. 6). These hypertrophied cells are filled with dense protoplasm which has a greater affinity for stains than that of normal cells. There are fewer chloroplasts in these enlarged cells than in the normal ones. In addition to the hypertrophy, necrosis of the spongy parenchyma cells is common (Fig. 6).

Microscopic examination failed to show the presence of any organism in the affected tissues, and platings on different media also failed to give rise to any bacterial or fungus growth. The behavior of the disease in the field also suggests that it is of a non-parasitic nature. The disease is limited to certain trees only, and all the leaves, both young and old, on those trees are affected. It was often noted that branches of trees showing this condition intermingled with branches of neighboring trees so that their leaves rubbed against each other, yet the spotting was limited to the leaves of one tree only.

This peculiar disease, also, is apparently of minor economic importance.

WHITE TREE

A peculiar condition which is known locally as "white tree," because of the whitish appearance of the leaves and the lighter color of the bark and fruit, was noted on a few trees in commercial plantings in the vicinity of Bogalusa.

Symptoms: The tree as a whole is somewhat stunted. The leaves are very small (approximately ⅛ as large as the average on normal trees) and stand erect instead of drooping, and their margins tend to cup upward. The under surface of the leaf is covered with pubescence (normal leaves are smooth), which gives it a whitish appearance as if affected by powdery mildew. The upper surface of the leaf shows irregular brown spots or patches which usually follow the veins. The bark is of lighter color than that of normal trees, as are also the husks of the immature nuts. White trees either do not set fruit at all, or, if set, the nuts do not fill well. Affected trees are apparently more susceptible to cold injury than the normal ones, for several white trees were killed to the ground in the winter of 1934-1935.

Cause: The cause of "white tree" is not known. The foreman of the plantation in which this trouble was found stated that several such trees appeared in an early planting of about 800 trees originating from one lot of seed obtained from Alabama, but that since then, the trouble can be recognized the first year while the trees are still in the nursery, and such trees are destroyed. If it is true that the trouble appears in the nursery the first year, it is probable that it is a genetic peculiarity. However, in one of the original plantings referred to above, seven white trees were found on one relatively small spot (about ½ acre in area), and if the trouble is of a genetic character a more random distribution of affected trees would be expected.

DISEASES NOT SEEN IN LOUISIANA

Mention should also be made of two diseases of tung trees reported from elsewhere but which have not been seen in Louisiana. These are "bronzing" and nematode root-knot.

Bronzing: This disease has been reported from Florida and has been shown by Mowry and Camp (5) to be due to zinc deficiency in the soil. The main symptoms of this disease are a bronze coloration and malformations of the leaves, defoliation, shortening of the internodes, stunted growth, and general weakening of the entire tree. Bronzing has not been observed in Louisiana.

Root-knot (caused by the nematode *Heterodera marioni*): This disease also has been reported from Florida by Newell, Mowry, and Barnette (6). Although root-knot on tung trees has not been seen in Louisiana, it does not mean that it does not occur. Nematodes infest many Louisiana soils and attack many crop plants, and it is to be expected that tung trees will become infected if planted on nematode-infested soil. That root-knot has not become troublesome on tung trees in Louisiana may be due to the fact that practically all the tung groves in the state are planted on new cut-over land that has never been in cultivation before.

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Crops and Soils Information

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LOUISIANA STATE UNIVERSITY

AND

AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

CARDED
R.G.P.

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Crops and Soils Information

INTRODUCTION

This report contains a summary of results obtained by the Crops and Soils Department of the Louisiana Agricultural Experiment Station during the years 1926-1936. Some of the experiments were run but a short time. Results from such experiments must be taken as tentative only. The discussions give, in brief, data on a part of the various subjects about which information is sought from the department by farmers of the State. While the discussions are not long, it is believed that they may be of some aid in giving easily available information to the busy farmer. References are given to other bulletins that may be read if more detailed information is sought.

In addition to the work mentioned in the following discussion, research men of the department have carried on some technical work on rice and sugar cane, and some co-operative work on rice, sugar cane, and pastures. Since this work has been or will be reported elsewhere, no further mention of it will be made here.

PART I

H. B. Brown, J. R. Cotton,* and D. C. Neal†

COTTON

The cotton work of the Department has dealt with the adaptation of varieties of cotton to various parts of the State, genetics studies, the breeding of better varieties for Louisiana, disease control by seed treatment, boll weevil control, certain phases of cotton culture, and cotton fiber studies.

Cotton Varieties for Louisiana. During the past ten years, 142 different cotton variety tests have been conducted in different parts of Louisiana in an effort to determine the best varieties in the various sections. It has been found that on the average, the annual monetary return from well adapted varieties is about $25.00 more per acre than from the poorly adapted varieties. The tests that have been conducted give a good indication of the value of varieties for different localities. From these studies and from general observations of crops grown, it appears that cottons of a vigorous type, such as D&PL 4-8, are best for the less fertile hill lands of northern Louisiana. A somewhat more prolific type such as D&PL 10, Stoneville-3 or 5, or Deltapine (D&PL 11) will be better for the richer hill lands and the small valleys of the region just mentioned. If many plants grown on the land die with the cotton wilt disease, it will pay to plant a wilt resistant variety. Dixie Triumph has yielded better than any other wilt resistant variety planted in the State. All of the varieties mentioned have a fair to good gin turnout and a satisfactory staple length.

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In the prairie district of southwestern Louisiana, the varietal adaptations are about the same as in the region just mentioned; that is, D&PL 4-8 type for the poorer lands and Stoneville, Deltapine, and D&PL 10 for the richer ones. If the grower wants a long staple cotton, Delfos-531, Delfos-2323-978, or Delfos-5555 (Missdel-4) are probably the best.

In the richer delta and alluvial lands of the State, especially on the Mississippi and Red river alluvial lands, varieties of the Delfos type have in general given the best returns. On less fertile alluvial lands, Stoneville, Deltapine, and D&PL 10 have done well. If the farmer wishes to grow a long staple cotton on land that is badly infected with cotton wilt, he should plant Express-317 or Express-121 (Delpress). If he wants to grow a cotton with staple still longer than that of any of the varieties mentioned, Wilds is probably the best.

The Experiment Station tests have shown that Mebane Triumph, Lone Star, Kasch, Lankart, Texas Rowden, Acala-8, Qualla, and other of the Texas Big Boll varieties are poor producers in Louisiana.

Table I gives the main characteristics of ten of the leading varieties grown in the State. The figures given are averages, for a five-year period, of crops grown on alluvial land at Baton Rouge, Louisiana. Stoneville-5 and Deltapine are both excellent varieties but it is not fair to compare their yields with the yields of varieties in tests for a longer time. Production varies in different years.

TABLE I. CHARACTERISTICS OF TEN LEADING COTTON VARIETIES

Variety	*Lint per Acre*	*Lint per cent.*	*Lint Length*	*Bolls per Pound*	*Value of Lint and Seed*
Wilds........................	356.4	30.1	1 1/4	61	66.77
Stoneville—3..................	613.6	34.3	1 1/32	73	90.41
Stoneville—5*.................	691.0	35.1	1 1/32	72	119.49
Delfos—531....................	577.8	33.4	1 1/8	71	89.85
Delfos—2323-978...............	554.2	31.3	1 1/8	75	87.75
Missdel—3.....................	414.8	31.4	1 1/8	63	65.85
Deltapine†....................	628.0	38.8	1 1/16	71	95.60
D&PL—10.......................	592.2	34.6	1 1/32	71	86.64
Dixie Triumph.................	508.5	32.8	31/22	72	72.27
Express—317...................	518.2	33.0	1 1/8	72	81.06

*Three-year average.
†Four-year average.

(Further information about cotton varieties and other work conducted by the Crops and Soils Department may be had from the Preliminary Report issued each year.)

Practical Cotton Breeding. In the practical cotton breeding work, an effort is being made to develop better varieties for each of three main soil regions of the State. Some gains have been made but no outstanding results have yet been secured. When good varieties exist already, it is not an easy task to produce better ones. However, some progress has been made. A strain known as D&PL 8-829 seems to be some improvement over the parent strain D&PL 4-8, for North Louisiana conditions. It is more uniform, has a better picking boll, and on a six-year average shows slightly better production, higher lint percentage, and slightly better staple length.

FIGURE 1. EXPERIMENTAL PLOTS OF COTTON AND CORN. DATE OF PLANTING CORN PLOTS IN THE BACKGROUND.

At the Northeast Louisiana Station at St. Joseph, the work has been on Delfos and Express varieties. Two good strains of Delfos, 2323-978 and 2323-130, have been developed. The first strain made more than 20 bales of cotton on 8 acres in 1936. The second is very prolific and dwarfish in type. It is probably the best Delfos strain in existence for rich land.

At Baton Rouge the principal breeding work has been on Dixie Triumph, Stoneville, and hybrid strains. An effort has been made to increase the length and uniformity of the staple of Dixie Triumph. Considerable progress has been made but there is still room for further improvement. One of our strains of Dixie Triumph was chosen by the U. S. Department of Agriculture to put in the National Regional Cotton Variety Test. Some of the hybrid strains on hand at present and other new selection strains show much promise, but it will require further time to determine their merits fully. One of the new hybrid strains ranked second in the State tests in 1936 and has ranked high consistently for three years. Some of the new strains of Stoneville are good cottons but no definite improvement over the original strains.

Okra-leaf Cotton. Plants with very deeply-lobed leaves that resemble the leaves of okra plants to some degree (the leaf lobes of Okra-leaf cotton are slenderer) are occasionally found in cotton fields. (See Figure 2.) We have records of them in 25 different varieties. They are apparently caused by a mutation and breed true if grown in isolation.

In 1928 an okra-leaf plant was found in a field of Delfos cotton on the Experiment Station farm. It was prolific and had such light foliage that it was thought that a strain developed from it might be well adapted to rich bottom lands where the plants become very large, and where the heavy growth of leaves on the broad-leaf plants makes so much shade that boll weevils multiply undisturbed by the sun's rays and boll rots are prevalent. The Okra-leaf strain mentioned was purified, increased, and planted in comparison with some of the better broad-leaf varieties. Bloom counts made in the test showed that the Okra-leaf strain bloomed 50 per cent more than any other variety in the test, but the shedding rate of small bolls was unusually heavy. In a test of 20 varieties the Okra-leaf strain ranked nineteenth, eleventh, and sixteenth in production in consecutive years. Boll counts showed fewer rotten bolls on the Okra-leaf plants. The test was not conducted in such a way that comparative weevil resistance could be determined.

Crosses were made between the pure Okra-leaf strain and several of our best varieties to see if the better characters of the latter could be combined with the light foliage character of the Okra-leaf. In 1935 and 1936, several strains developed from such crosses were tested in comparison with the pure Okra-leaf strain but were found to be but slight improvements insofar as yields were concerned. The foliage on the Okra-leaf cotton is so light that apparently there is not enough leaf area to elaborate foods enough to support a large crop of developing bolls. The light foliage is also a hindrance in that the ground is not shaded enough to prevent rank growth of grass and weeds in the cotton after it is laid by.

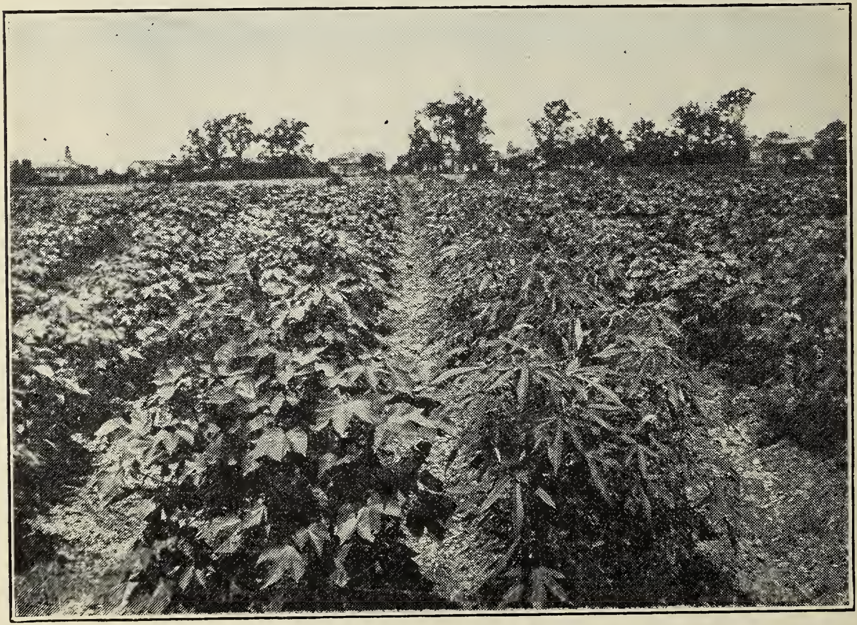

FIGURE 2. ROW OF OKRA-LEAF COTTON (RIGHT-CENTER) AND BROAD-LEAF ROWS.

Round-leaf Cotton. An interesting new variety of cotton has been produced in the breeding plots of the Experiment Station at Baton Rouge. This strain originated from a single stalk selection made in 1930 in an increase block of Express-317.

While this variety is of slight commercial value, it is immensely interesting from a genetic standpoint. The breeding results of an outstanding strain of this kind may throw much light on the results to be expected from less evident but more valuable characters in breeding for commercial improvement.

This variety has many features not found in normal cotton. Leaves are rounded, crinkled, and somewhat thicker than the normal. Plants are dwarfish, stocky, and more bushy. Vegetative branches are distributed along the main stem rather than near the base of the stalk as is common in normal cotton. Flowers are small and flower bracts of odd shapes, mostly lanceolate and entire. Bolls are small and rounded at the point. Lint is shorter than is found in the parent strain, Express-317, and the percentage is lower.

In crosses between Round-leaf and Normal-leaf cotton, the F_2 generation showed a ratio closely approaching 1 to 3; i.e., 1 Round-leaf and 3 Normal-leaf plants. In crosses with Okra-leaf cotton, 6 different types appeared in the F_2 generation, which closely approximated the following ratio: 1 Round-leaf, 3 Normal-leaf (which was not expected), 3 Okra-leaf, 6 intermediate between Okra-leaf and Normal-leaf, 1 intermediate between Okra-leaf and Round-leaf, and 2 showing intermediate Round-leaf, Normal-leaf, and Okra-leaf. The intermediate Okra-Round type proved to be a new strain which breeds true.

Other outstanding features were found in this variety. One or more plants each year have produced sporting branches with normal leaves; however, the seed from these branches, kept pure, produce only Round-leaf plants. In 1936 one of the Okra-Round-leaf plants produced a sporting branch bearing leaves of the Okra-leaf type.

Further study is being made on the breeding of this variety and a detailed account of results will be published at a later date.

Effect of Inbreeding Cotton. In 1928, a rather extensive experiment was started to find out whether inbreeding reduces the vigor and production of cotton plants as it does corn and some other plants. If inbreeding does not reduce vigor, it can be used as a tool to purify strains and to make them more uniform. The experiment was started with eight varieties illustrating different varietal types. The first year a test was made, all of the strains that were crossed within the variety made more cotton than the selfed strains, the average increase being 16.1 per cent. The next three years, there seemed to be very little difference between the two strains but the crossed strains were slightly ahead in yields every year except one. During the last four years the crossed strains have led in production consistently. The lead in 1935 was 18.6 per cent. Crossing also increased boll size and rate of blooming. Since it was necessary to hand-pollinate flowers for all the seed used in planting, it was not feasible to have large numbers of plants each year. This may have affected results some years and made conclusions uncertain. It now seems fairly evident, however, that the inbreeding does reduce production to a limited extent, and it also seems to reduce boll size, rate of blooming, and vegetative growth early in the season. Later in the season, plants with fewer bolls make greater vegetative growth. The effect of inbreeding on lint length, on lint percentage, and on some other characters was also studied but no certain effect could be determined.

Effect of Fertilizers on Earliness. The object of this experiment was to see what effect the common fertilizer ingredients would have on earliness in cotton when used under field conditions. For five years, during the main blooming period, daily bloom counts were made on 28 plats in the general fertilizer experiment. This experiment was located on Lintonia silt loam soil at Baton Rouge. The treatment of the different plats, the average blooming rate, and the average yields for the whole period are shown in Table II.

TABLE II. EFFECT OF FERTILIZERS ON EARLINESS OF COTTON

Fertilizer Treatment	*Blooms First Week*	*Blooms Second Week*	*Blooms Third Week*	*Blooms Fourth Week*	*Blooms Fifth Week*	*Yields Seed Cotton*	*Percentage First Picking*
No phosphorus	714	1589	1479	1911	1921	66.8#	47
Total blooms to date	....	2305	3782	5693	7614	....	....
High phosphorus	1228	2561	1854	1953	1682	74.3	65
Total blooms to date	....	3789	5643	7596	9278	....	..
No nitrogen	741	1534	1340	1461	1385	55.2	59
Total blooms to date	....	2275	3615	5076	6461	....	..
High nitrogen	956	1904	1542	1630	1697	76.4	54
Total blooms to date	....	2860	4402	6032	7729	....	..
No potash	929	1764	1594	1771	1563	65.8	59
Total blooms to date	....	2693	4287	6058	7621	....	..
High potash	864	1944	1575	1894	1652	82.2	53
Total blooms to date	....	2808	4383	6277	7929	....	..
No fertilizer	590	1371	1216	1468	1322	47.4	52
Total blooms to date	....	1961	3177	4645	5967	....	..

It will be observed that the high application of phosphorus fertilizer increased the blooming rate for the first four weeks and gave the highest percentage of yield at the first picking but not the highest total yield.

The high nitrogen application increased the blooming rate over no-nitrogen throughout the whole period and increased total yields. Nitrogen is the fertilizer most needed on this soil. The percentage of cotton the first picking was higher on the no-nitrogen plats than on the high-nitrogen due to the fact that the less vigorous plants stopped fruiting sooner.

The high application of potash reduced the blooming rate the first week, compared with the no-potash, but the total blooming and yield of cotton were increased. Potash is badly needed on this land.

The no-fertilizer plats, as was to be expected, had the lowest blooming rate and made lowest yields.

From the results of this experiment, it appears that phosphorus does increase earliness to some degree and potash decreases it, but the decrease may be more than balanced by the benefit shown later in increased growth and production.

Effect of X-rays on Cotton. Within the last few years a number of investigators have used X-rays on plants in an effort to produce mutations. Killough and Horlacher of Texas were the first to experiment with the effect of X-rays on cotton. They obtained some interesting results but no mutations of any economic importance.

In 1933, C. B. Roark, a graduate student in the Agronomy Department at Louisiana State University, tried the use of X-rays on cotton seed, both dry and soaked, and on flower buds. The length of treatment was varied from a few minutes to several hours. Soaked seed that were treated for an hour or more failed to germinate. The germination of the treated seed was lower than the untreated checks in nearly all cases. Plants grown from the treated seed were all somewhat abnormal and smaller than the check plants. Both the second generation plants grown from selfed seed produced on the plants that were grown from treated seed, and second generation plants grown from seed from rayed flower buds, showed more variation than the untreated lines that were used as checks. Unfortunately it was not possible to study these plants in detail nor to grow them in later generations. Nothing of economic importance appeared.

Cotton Seed Treatment. Within recent months there has been considerable interest in seed treatment to improve germination, to aid in the control of seedling diseases, and to facilitate more uniform planting. Unfortunately, a part of this interest is due to propaganda put out by companies that wish to profit by delinting the seed, or to sell material to use in treating the seed, or to sell new planters made to plant the delinted seed. The Crops and Soils Department conducted delinting experiments two different years. Each year several thousand seeds, both delinted and undelinted, were counted out and planted. Five different varieties or strains were used. In two cases, the normal seeds gave the highest germination and in three cases, the delinted, but the differences in rate were not great. The results for 1928 are shown in Table III.

TABLE III. EFFECT OF SEED TREATMENT ON GERMINATION

Variety		*Number Plants merged*	*% Germination*
822x65-42	3500 delinted seed planted	904	25.8
822x65-42	3500 regular seed planted	957	27.3
822x65-41	3000 delinted seed planted	944	31.4
822x65-41	3000 regular seed planted	654	21.8
41-311	3000 delinted seed planted	1203	40.0
41-311	3000 regular seed planted	986	32.8

The resultant stands on all plats were sufficient to give all the plants needed when the cotton was chopped out. There was no significant difference in yield of seed cotton when the cotton was picked.

In 1931 and in 1932 limited tests were made on the effect of Ceresan on seed germination and on the control of disease in young plants. Both years the germination was slightly better where the seed had been treated and fewer seedlings were diseased. In 1931, six per cent of the plants from treated seed and 14 per cent from the untreated seeds were diseased. The stands were good on both sets of plats, however, and at harvest the untreated plats yielded 127.0 pounds of seed cotton and the treated 123.8 pounds, an insignificant difference.

In 1935 and 1936, Dr. D. C. Neal, of the U. S. Department of Agriculture, carried on seed treatment experiments in co-operation with the Experiment Station. Results for 1936 are shown in Table IV.

TABLE IV. FURTHER STUDIES WITH SEED TREATMENT

Treatment—4 oz. dust per bu. seed.	*Average per cent Emergence*	*Yield Seed Cotton per Acre, Pounds*
Ceresan	69.2	1387
Improved Ceresan	43.2	1475
Sulphuric acid delinted	41.0	1238
Sulphuric acid delinted plus Ceresan	47.7	1188
Red Copper Oxide	38.6	1525
Metrox	39.1	1575
Untreated	34.4	1363
Treatment—2 oz. dust per bu. seed		
Ceresan	49.8	1225
Improved Ceresan	48.7	1250
Red Copper Oxide	36.6	1175
Untreated	32.9	1063

Boll Weevil Control. On account of the mild winters, frequent summer rains, and the rank growth of cotton plants, boll weevils are more difficult to control in South Louisiana than in most other parts of the Cotton Belt. In fact, the difficulty is so great that farmers here have largely abandoned cotton as a crop. The Crops and Soils Department has carried on no regular boll weevil control experiments, but it has been necessary to do a good deal of boll weevil control work in order to protect cotton in other experiments. A brief mention of methods used may be of some aid to farmers who wish to grow cotton under conditions that prevail in South Louisiana.

Many weevils that have survived the winter are always present in the cotton before squares are large enough to puncture. A thorough pre-square poisoning with calcium arsenate dust or poisoned molasses destroys many of these. The weevils tend to go to the earliest cotton and if this is poisoned thoroughly, control measures are aided. Later, infestation counts are made weekly and the weevils watched closely. If the infestation runs as high as 5 per cent, weekly poisonings are made, using 6 to 10 pounds of calcium arsenate per acre. Heavier applications are made as the plants grow larger. When the infestation counts show many adult weevils, numerous young weevils hatching out, or many in the pupa stage, extra effort is put forth to keep poison on the plants. If rains occur, extra poisonings are made. On account of the difficulty of weevil control in this area, earlier, more frequent, and heavier applications of poison are used than are recommended by the Bureau of Entomology for weevil control. The methods outlined have been very satisfactory in holding the weevils in check and good crops have been made. Yields have averaged approximately a bale per acre for a 10-year period, while neighboring farmers who did not use poison made less than half a bale. However, some other factors also had a bearing in the matter.

Oil Content of Louisiana Cotton Seed. During two different years, samples of cotton seed have been taken from variety tests conducted in different parts of the State and have been analyzed for oil content by A. P. Kerr of the Fertilizer and Feedstuffs Laboratory. Table V gives the percentage of oil of different varieties at different places.

TABLE V. OIL CONTENT OF COTTON SEED IN 1931 AND 1935 TESTS IN LOUISIANA

Variety	*Baton Rouge, Bench Land*	*Baton Rouge, Alluvial Land*	*St. Joseph. Alluvial Land*	*Calhoun, Hill Land*	*Varietal Average 1931*	*Baton Rouge, Bench Land*	*Baton Rouge, Alluvial Land*	*Crowley, Prairie Land*	*St. Joseph Alluvial Land*	*Calhoun, Hill Land*	*Varietal Average 1935*
	%	%	%	%	%	%	%	%	%	%	%
Missdel 1	16.65	17.60	18.10	16.54	17.22	......	......	......	......	......	......
Delfos—1341	17.48	17.03	16.87	15.29	16.66	......	......	......	......	......	......
Half & Half	16.95	18.72	19.10	17.02	17.94	......	......	......	......	......	......
Rowden—40	17.00	17.41	17.39	16.11	16.97	......	......	......	......	......	......
Wilds	17.42	16.43	20.72	16.11	17.67	......	......	......	......	......	......
Delfos- 531	16.23	16.81	17.68	15.24	16.49	18.90	21.50	18.80	21.75	17.70	19.7
Cleveland—5	15.64	16.55	18.42	17.58	17.04	......	......	......	......	......	......
Stoneville—2	15.54	17.62	18.97	15.65	16.94	......	......	......	......	......	......
Stoneville—3	17.80	18.07	17.97	16.92	17.69	18.50	20.20	19.70	21.75	17.85	19.05
Dixie Triumph	19.35	17.16	......	17.00	......	20.05	21.60	......	21.25	17.25	......
Acala—37	16.44	18.14	18.64	16.88	17.52	......	......	......	......	......	......
D&PL—4	18.93	17.03	18.87	16.39	17.80	......	......	......	......	......	......
D&PL 4-8	17.34	18.52	19.65	16.63	18.03	......	......	......	......	......	......
D&PL—10	19.92	17.18	17.64	15.65	17.59	17.95	19.55	18.10	20.10	17.50	18.6
Express—317	18.16	18.44	19.46	16.57	18.15	......	......	......	......	......	......
Mebane	16.71	16.65	16.00	14.83	16.04	17.25	19.30	16.50	19.25	16.40	17.7
Wannamaker Cleveland	17.42	17.91	17.41	15.17	16.97	......	......	......	......	......	......
Wilson Cleveland	17.09	17.00	17.99	14.60	16.67	......	......	......	......	......	......
Location Average	17.33	17.45	18.28	16.11	......	18.5	20.4	18.2	20.8	17.3	......

It is generally conceded that the varietal factor is of greater importance than any other in determining the oil content of seed. The above table shows that the soil on which the seed are grown does have some effect. The plantings on the richer alluvial lands consistently had seed with higher oil content.

COTTON CULTURE

During the past several years the Experiment Station has carried on a limited amount of cotton culture work at Baton Rouge. This has comprised tests of date of planting on bench land, spacing on bench and alluvial lands, ridged versus level or nearly level culture, effect of root pruning, and effect of subsoiling.

Date of Planting on Bench Land. The cotton in this test was planted on medium fertile land and given the normal culture for the region, the only exception being the variable planting date. The planting dates were April 1, 11, 21, and May 1 and 11. Blooming, boll opening, and yields for the different planting dates in 1933 are given in Table VI.

This experiment was run for a five-year period. The dates used covered the range of dates of practical importance in planting. There was some variation in results for different years, depending upon seasonal conditions. If the weather was cold and wet early in April, the first plantings gave poor stands and yields were lower in consequence. The later plantings usually gave good stands but their yields depended largely upon the prevalence and control of boll weevils. May 11 invariably gave lowest yields. In some years the May 1 plantings gave the highest yields, but April 21 ranked highest on the average.

TABLE VI. DATE OF PLANTING COTTON

Planting Date	*Blooming Date*	*Days from Planting to Blooms*	*Bolls Open*	*Days from Blooms to Open Bolls*	*Pounds Seed Cotton per Acre, 1933*	*Pounds Seed Cotton per Acre, 5-Year Average*
April 1	June 5	65	July 26	51	1819	1646
April 11	June 11	61	July 31	50	1780	1715
April 21	June 17	57	August 2	46	2191	1792
May 1	June 23	53	August 11	49	1086	1628
May 11	July 3	53	August 24	52	834	1446

Cotton Spacing. Many experiments have been conducted throughout the Cotton Belt to determine the proper width of spacing for cotton. In regions of rather low fertility and moderate rainfall, best results were obtained from close spacing of plants—8 to 15 inches apart. Where soil is rather fertile and rainfall heavier, wider spacings were found to give better results.

Spacing experiments were conducted for five years at Baton Rouge for the purpose of determining the best spacing for southern Louisiana conditions. These experiments were run on both alluvial and bench lands and included five spacings as follows: Unthinned; two stalks spaced 10 inches; two stalks spaced 20 inches; two stalks spaced 30 inches; and one stalk spaced 30 inches.

Studies were made on a number of factors which influence production and quality of lint, some of which were size of plant, rate of blooming, rate of shedding, length of staple, per cent of boll rot, lint percentage, size of bolls, and pounds of seed cotton per acre.

Table VII shows an average of the results from the five years' data.

TABLE VII. RESULTS OF VARIOUS SPACINGS ON GROWTH AND YIELD OF COTTON

Spacing	*Height of Plant in Inches*	*Average Daily Blooming*	*Average Daily Shedding*	*Bolls Per Pound*	*Per cent Boll Rot*	*Seed Cotton per Acre*
Bench Land Test						
Unthinned	34.8	47.1	43.8	78.0	13.5	999
2 Stalks 10 inches	37.8	48.2	39.8	73.7	11.5	1180
2 Stalks 20 inches	43.0	47.6	30.9	69.7	8.2	1269
2 Stalks 30 inches	42.2	44.0	26.2	68.0	10.2	1233
1 stalk 30 inches	43.3	41.9	15.3	64.3	8.2	1115
Alluvial Land Test						
Unthinned	42.7	74.7	157.0	91.0	14.5	1362
2 Stalks 10 inches	48.9	78.8	186.0	80.0	10.8	1823
2 Stalks 20 inches	50.3	69.6	156.0	77.7	9.9	1835
2 Stalks 30 inches	49.6	57.5	130.0	75.7	10.1	1786
1 Stalk 30 inches	47.7	49.8	77.0	72.0	7.6	1816

A study of the data shows that width of spacing has little effect on lint percentage, that the rate of blooming is somewhat higher in the narrow spacings, and that boll rot is appreciably higher in the closely spaced cotton. Plants were taller in the intermediate spacings, but more tonnage of plants was produced in the unthinned plots.

Rather marked effect on the size of bolls was found, the narrower spacings producing the smallest bolls, and the size of bolls increased as the spacings widened.

It appears that length of staple is affected to some degree by the width of spacing. An average of three years' data showed more than 1/16-inch difference in staple length between the widest and the narrowest spacings used.

Shedding was much heavier in the close spacings in the early part of the fruiting season and appreciably heavier for the average of the season.

The acre yields indicate that two stalks per hill spaced 20 inches apart in the drill is best on both the bench lands and the alluvial lands.

High and Low Bed Culture. Experiments have been conducted for six years to determine the effect of growing cotton on high beds or ridges as compared with low beds. Although eight experiments have been conducted, results are not conclusive. A number of factors, such as soil conditions, rainfall, cultivation, prevalence of boll weevil, etc., have a bearing on results and may vary different years. Consequently, considerable study is necessary to determine the principles involved. Table VIII gives a summary of the results obtained, although, as was stated above, they are not conclusive.

TABLE VIII. HIGH AND LOW BED COTTON CULTURE

Location	*Year*	*Height of Plants Inches*		*Yields Seed Cotton Pounds*	
		High Beds	*Low Beds*	*High Beds*	*Low Beds*
Bench land	1931	38.4	34.9	1536	1623
" "	1932	46.3	49.3	1016	1104
" "	1935	....	....	1804	1629
" "	1936	33.2	32.7	1172	1436
Alluvial land	1933	47.4	46.3	2677	2548
" "	1934	54.9	57.1	1250	1137
" "	1935	56.1	58.4	1777	1515
" "	1936	32.1	33.5	2020	1920

In three tests out of four, on the Bench land, the low bed plats gave the greater yields, while on the alluvial land, the high beds invariably gave better yields.

Effect of Root Pruning by Deep Plowing on the Growth and Production of Cotton Plants. On the richer lands of South Louisiana, there is a tendency for cotton plants to make such rank growth that they do not fruit well and there is much boll rot. This experiment was started to determine whether or not it was possible and practical to hold down the excess vegetative growth by root pruning in deep plowing. Three methods of plowing were tried—deep plowing near the plants with small shovel plows; medium deep plowing with large shovels on a double shovel; and shallow cultivation with buzzard wing sweeps.

Weather conditions affected results in a number of cases and made it more difficult to draw conclusions. Table IX gives the average plant height and plat yield of seed cotton for the different treatments for a six-year period.

TABLE IX. ROOT PRUNING EXPERIMENT

Treatment	*1929*		*1931*		*1932*		*1933*	
	Plant Height	*Cotton Yield*	*Plant Height*	*Cotton Yield*	*Plant Height*	*Cotton Yield*	*Plant Height*	*Cotton Yield*
	Inches	*Pounds*	*Inches*	*Pounds*	*Inches*	*Pounds*	*Inches*	*Pounds*
Deep plowing............	53.1	84.5	29.5	166.4	41.6	133.0	43.3	49.6
Medium plowing.........	55.8	80.2	30.5	184.6	42.8	136.8	46.7	49.9
Shallow plowing..........	53.8	82.8	32.2	178.2	44.7	136.5	47.9	51.0

Continued

Treatment	*1934*		*1935*		*Six-year Average*	
	Plant Height	*Cotton Yield*	*Plant Height*	*Cotton Yield*	*Plant Height*	*Cotton Yield*
	Inches	*Pounds*	*Inches*	*Pounds*	*Inches*	*Pounds*
Deep plowing............	54.2	51.5	52.4	185.0	45.8	111.7
Medium plowing.........	57.6	52.0	50.7	193.2	47.3	116.1
Shallow plowing..........	57.7	48.1	51.3	185.3	47.6	113.6

The deep plowing reduced the growth in height rather consistently but the decrease was not great. This decrease in height did not improve yields but seemed to reduce them. The decrease in yields was probably due to increased shedding that followed deep plowing. The margins of difference are slight and are probably not significant. The use of root pruning as a means of preventing excessive vegetative growth is of doubtful value as a practical measure, however.

Subsoiling Bench Land for Cotton. Over much of the Bench Land on the Experiment Station farm, the top surface of the subsoil is rather hard. If the season tends to be dry, few cotton roots penetrate it. Even the tap root turns, in most cases, when it strikes this layer and runs off laterally. In 1932 an experiment was run to see if breaking this hardpan by subsoiling would benefit cotton plants grown on the land. Four five-row plats were subsoiled by making furrows with a middle burster where the rows were to be, and running a subsoil plow in the bottom of the furrow. Then a bed was made on this subsoiled furrow. Four other five-row plats alternating with these were treated the usual way and used as checks. Good stands were obtained on all the plats and the cotton grew well and was very uniform. During the growing season no difference could be seen between the two sets of plats and when harvested there was practically no difference in yields, the total difference being but three pounds. Apparently subsoiling is of no value to cotton on Bench Land soil at Baton Rouge.

Cotton Root Studies. Rather extensive studies have been made of the root development of the plants of a number of field crops, but only a limited amount of work has been done on cotton plants. The Louisiana Experiment Station made certain studies for a period of three years on Lintonia silt loam bench land soil and on Sharkey clay alluvial land. Insofar as could be determined from the study made, there was no consistent difference in the root systems of 20 varieties grown in 1931. There was considerable difference in the spread of the roots in the two types of soil used. On the bench land soil, the roots were confined mainly to the upper 6 or 8 inches of soil but where the soil was exposed to the sun, there were few roots in the upper 2 or 3 inches. A few roots penetrated the subsoil to a considerable depth. One was traced to a depth of 7 feet, 2 inches. On the alluvial land the roots were well distributed through the upper 18 inches of soil and a few roots penetrated the soil below this for a considerable depth. One was traced to a depth of 5 feet, 2 inches.

It was observed that during dry seasons when the plants made less growth, there was less root development in lower layers of soil. This was probably due, in part, to the fact that the dryer subsoil was more dense and harder to penetrate.

As there were but few roots in the upper two or three inches of soil, ordinary cultivation is not apt to injure the plants seriously by breaking their roots.

(Additional data on cotton root development may be found in Louisiana Bulletin No. 232.)

Cotton Fiber Studies. Some preliminary studies have been made of the uniformity and length of staple of the leading commercial cotton varieties grown in Louisiana. Table X gives in brief, data obtained from a study of cotton grown on alluvial land at Baton Rouge in 1933.

OTHER FIBER PLANTS

During the past few years, the Crops and Soils Department has done a limited amount of work on ramie, hemp, and flax—other fiber crops of some interest but of slight value in the South in comparison with cotton.

Ramie. Ramie (*Boehmeria nivea*) is a plant belonging to the nettle family. Its bark contains a very strong fiber which is valuable for weaving cloth, making cordage, and for other purposes. Ramie has not come into extensive use because it is necessary to strip the bark from the plants by hand and then scrape it to remove the corky surface layer. Most of the ramie in commerce comes from China where there is an abundance of cheap labor.

The Experiment Station has grown ramie to supply material to people experimenting with decorticating machines, and to determine the productivity of the plant when grown under Louisiana conditions.

From the rather limited experiments carried on for five years, it seems that there is no question that ramie can be grown easily and that it will produce well in South Louisiana. In 1929 a planting was made on Lintonia silt loam soil of medium fertility. Four-foot rows were used, and pieces of root-stocks planted at one-foot intervals in the row. The first year, the plants were hoed twice and cultivated about the same as cotton. Since the plants were perennials, no planting was needed after the first year. Also, no hoeing, and not much plowing was done after the first year.

The first year the plants grew and spread but none were ready to cut for fiber. The second year, three cuttings were made, yielding a total of 42,000 pounds of

TABLE X. COTTON FIBER STUDIES

	Staple Length Ordinarily Given by Commercial Classers. Inches.	*Extreme Staple Length Given by Sorter. Inches*	*Mode in Sorter Array. Inches.*	*Per cent of Fibers 7/8-Inch and Longer*	*Commercial Classing of Machine-Ginned Sample. Inches.*	*Extreme Length in Array of Machine-Ginned Sample. Inches.*	*Per cent of Fibers 7/8-Inch and Longer in Machine-Ginned Sample.*
Wilson Cleveland	15/16 to 1	1	7/8	30.0	15/16	1 1/16	21.8
Half and Half	13/16 to 7/8	7/8	11/16	8.5	7/8	15/16	8.7
Dixie Triumph	15/16 to 31/32	1 1/16	13/16	41.9	31/32	1 1/16	36.9
Lankhart	1 to 1 1/16	1 3/16	1	65.7	31/32	1 1/4	41.5
Station Miller	31/32 to 1 1/32	1 3/16	15/16	57.0	1 1/32	1 1/8	48.3
Rowden—40	31/32 to 1 1/32	1 1/16	15/16	47.7	1	1 3/16	48.1
Acala—37-6	1 to 1 1/16	1 3/16	1 1/16	69.0	1	1 3/16	42.6
Cleveland—5	1 to 1 1/16	1 1/4	1 1/16	56.1	1 1/32	1 1/8	44.4
D&PL—11	1 to 1 1/16	1 3/16	15/16	42.2	1 1/32	1 3/16	45.1
D&PL—10	1 to 1 1/16	1 1/4	15/16	64.0	1 1/32	1 1/8	46.1
D&PL—4-8	31/32 to 1 1/32	1 3/16	15/16	64.3	1 1/32	1 3/16	47.4
Stoneville—2	1 to 1 1/16	1 3/16	15/16	57.4	1 1/16	1 3/16	49.2
Stoneville—3	1 to 1 1/16	1 3/16	1	72.8	1 1/16	1 3/16	43.7
Delfos—531	1 1/8 to 1 5/32	1 3/8	1 1/8	77.6	1 5/32	1 5/16	54.6
Delfos—965	1 1/8 to 1 5/32	1 5/16	1 1/16	77.4	1 3/32	1 5/16	51.2
Delfos—2323	1 1/8 to 1 5/32	1 5/16	1 1/8	74.0	1 5/32	1 3/8	64.9
Missdel—1	1 1/8 to 1 5/32	1 3/8	1 1/8	78.5	1 1/16	1 5/16	59.9
Missdel—2	1 3/32 to 1 1/8	1 5/16	1 1/16	73.8	1 1/16	1 3/16	42.1
Express—317	1 1/8 to 1 5/32	1 3/8	1 3/16	82.2	1 1/8	1 5/16	50.9
Wilds—5	1 3/16 to 1 1/4	1 1/2	1 5/16	84.0	1 7/32	1 7/16	67.8
Average				61.20%			45.76%

(Additional data on cotton fiber studies may be found in Louisiana Bulletin No. 259.)

green, unstripped stalks per acre. The third year, the plants had spread over the ground well and produced 91,810 pounds of green weight per acre, which was an excellent yield. About half of this weight was leaves, and only about one-fifth of the green stem weight was dry matter. Only 20 per cent of this dry matter was fiber. But that, however, gave a fiber yield of more than 1500 pounds per acre. This weight is greater than could ordinarily be expected of plants grown under field conditions. These plants were grown on small plats and were given good care and fertilization.

Hemp. In response to inquiries in regard to growing hemp in Louisiana, a small planting was made on Bench Land soil in 1931. All of the hemp was planted in rows and cultivated, a part of it being drilled thick in the row to grow plants for fiber, while the rest was planted in hills and grown for seed. The seed rows were thinned to one plant in a hill. The fiber rows were planted May 1, and the seed rows on April 6. Both sets of plants made good growth but they were more or less diseased, a number of them dying with a sclerotial fungus disease. It is probable that if plants were grown on the same land two years in succession, this disease would kill a large part of the plants as it does sugar beets. The fiber plats were cut and weighed on August 21, and yielded 19,600 pounds of green weight per acre. According to Dewey, of the U. S. Department of Agriculture, an average crop gives a green weight of 15,000 pounds per acre. No seed weights were taken from the seed plats. It appeared that a fair crop of seed was produced. Some of these fell to the ground and produced a volunteer crop in 1932.

Flax. On May 14, 1932, some small plats of flax were planted on Bench Land soil at Baton Rouge. The land was well prepared and the flax planted in narrow rows and cultivated. The seed germinated at once and plants made rapid growth but did not become large. They were 12 to 20 inches in height when harvested on July 22. It appeared that the weather was too warm for them. An earlier planting would probably have been better. When the harvesting was done, there were still some blooms but most of the leaves had been shed and nearly all of the pods were about ripe. There seemed to be few good seed in the pods and some of the pods were decaying. The frequent summer rains probably fostered this rotting. Many plants died from wilt or other fungus disease.

The green weight of plants at harvest on July 22, was 1750 pounds per acre. This was a low yield. Probably the yields would have been much better if earlier planting had been made but it is doubtful whether flax is a good crop for South Louisiana.

SUGAR BEET INVESTIGATIONS

The Louisiana Experiment Station has conducted sugar beet experiments intermittently for the past 30 years. About 1926, when sugar cane production declined due to cane diseases, there was an increased interest in beet growing. The Experiment Station employed D. N. Barrow to do experimental work with the crop and outlined rather extensive experiments with varieties, culture, fertilizers, etc. In some years, under favorable conditions, good yields were obtained and the sucrose content of the beets was good, running as high as 14 per cent. It soon developed that the sclerotial root rot, which attacks the beet roots in the field as they approaach maturity, was the limiting factor. It frequently happened that after they had been shipped to the factory for slicing, whole carloads of the roots would have to be thrown away because of the action of this fungus, and half or more of the beets might rot in the field if the harvest was delayed after warm weather started.

After Mr. Barrow's death in 1929, the work was turned over to H. B. Brown and some breeding work was begun, looking toward the development of a rot resistant strain. Individual plant selections of apparently resistant plants were made in fields where most of the beets were rotting. These selected roots were placed in cold storage and handled in various other ways to carry them through a dormant period. They were later disinfected and set out, but in most cases rotted. In a limited number of cases, the plants went through the winter and sent up flowering stalks in the spring. Seed was obtained from four of these plants and four progeny rows grown. It could not be observed that the plants in these rows were any more resistant than those from unselected seed. However, the roots from these rows were saved and an effort was made to get them to produce seed. Not one of them did produce seed, so the strains were lost. The breeder is badly handicapped by the difficulty of getting the plants to produce seed regularly.

It seems doubtful whether sugar beet growing in Louisiana will be very successful. It is too hot to grow them during the summer. If planted in the fall all of them may be killed by a winter freeze. This happened two years out of the six during which the writer made observations. One other year the winter was so warm and humid that leaf-spot diseases were very prevalent, and the roots made poor growth. If planting is done during the winter, the plants may live but the roots do not reach merchantable size before warm weather comes on. If the weather is warm when the plants approach maturity, nearly 100 per cent of the mature beets may be infected with the root rot organism. These infected beets rot quickly during warm weather if piled together in bulk preparatory to slicing. Considering all of these hazards, it seems doubtful whether sugar beet growing can be made a profitable industry in Louisiana.

PART II

H. B. Brown and Hugo Stoneberg*

CORN WORK

Adapted Varieties. It has been demonstrated many times that seed from our southern varieties of corn will produce better locally than seed from the early northern varieties such as are grown in the Corn Belt states. Unfortunately for southern farmers, seed dealers in the South sell much of this northern-grown seed. It looks good, is cheap, and is easily obtained.

Under some conditions the one-ear varieties grown in the South are better liked than the small-eared prolific varieties, but, in general, the prolific varieties give better yields. The most productive one-ear varieties in Louisiana are Tuxpan, Imperial White, and Sentell. Sentell is better adapted to North Louisiana, and Imperial White to South Louisiana. There are several good prolific varieties. Cocke's Prolific, Hasting's, and Whatley have all ranked high in yield of grain per acre, with little difference in their yields. Cocke's Prolific has a slightly larger ear than the other varieties mentioned. A good many growers object to the prolific varieties on account of the small ear. However, the increased yield from the small-ear varieties repays the grower well for the extra work in harvesting. Hill's Yellow Dent is intermediate between the prolific and one-ear varieties in regard to the number of ears produced. It is a good yielder and probably the best yellow corn in the State. Jarvis Prolific,

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Good's Golden Prolific, and Yellow Creole are other yellow varieties that have been grown in tests, but they have ranked rather low.

Imperial White, Tuxpan, and Mexican June have given better yields than other varieties when planted after June 1.

TABLE XI. CORN YIELDS IN ALLUVIAL LAND VARIETY TESTS AT BATON ROUGE, 1933-1936 (Bushels per Acre)

Variety	*1933*	*1934**	*1935*	*1936*	*Four Year Average*
Silvermine	27.2	10.9	62.5	51.8	38.1
Surcropper	36.4	16.3	64.8	58.9	44.1
Calhoun Red Cob	38.6	11.9	75.0	46.2	42.9
Hill's Yellow Dent	46.7	16.4	78.2	63.5	51.2
Sentell's White Dent	41.5	14.4	71.8	50.2	44.5
Yellow Creole	44.8	15.0	71.7	49.5	45.2
Cocke x Creole F_1	51.9	18.4	81.2	63.9	53.8
Cocke's Prolific	44.9	11.6	80.6	57.4	48.6
Hastings'	47.4	15.7	83.1	53.3	49.9
Tuxpan	51.6	12.3	81.2	57.4	50.6
Imperial White	49.9	13.1	71.7	49.1	45.9

*In 1934 the crop was badly damaged by a storm on June 16.

Effect of Mass Selection on Cocke's Prolific. Recent studies have shown that mass selection of corn, that is, picking out best plants and harvesting them together, is the most simple and most effective method of corn breeding for the practical corn grower in the South. Selection in inbred lines followed by crossing may give hybrids that will yield somewhat higher than can be obtained by mass selection, but this method of breeding is too much for the ordinary grower.

In 1915 the writer began mass selecting a strain of Cocke's Prolific corn then being grown on the Experiment Station Farm at State College, Mississippi. The plants chosen were vigorous and had two fair-sized ears with good husk protection and medium smooth, semi-dent kernels. This semi-dent kernel seemed to be a hybrid form intermediate between rough dent and smooth flint corn. Being of hybrid constitution, selection over a period of 20 years failed to fix the type. The smooth-ear and rough-ear forms still arise, but the strain, having hybrid vigor, has given high yields very consistently. In Mississippi it ranked high in tests for 10 years. It was brought to Louisiana in 1927 and has the highest average yield of any variety grown in tests in Louisiana since that time.

The Use of Crossed Varieties. In 1928 a cross was made between Cocke's Prolific and Yellow Creole corn, the latter being a deep yellow, smooth kernel, prolific variety. The idea was to get a yellow corn that would have the high yielding qualities of Cocke's Prolific and the weevil resistance of the Yellow Creole. The first generation plants grown following the cross proved to be high yielders but the kernels were only a light yellow. The cross has been repeated some five times since 1928 and in every case the F_1, or first generation, plants have ranked high in yields, being in first place or near it in most instances.

Plant selections were made in the first generation plots in 1929 and only yellow kernels planted from the plants selected. Similar plans were followed in 1930 and each subsequent year. In 1936, the strain was nearly pure yellow. Every kernel contained some yellow pigment but there was a considerable variation in the depth of coloring. Further selection will probably deepen the coloring and make it less variable. This strain has ranked better in yields than the average of varieties in the tests, but has not done as well as the first generation crosses.

Several other crosses between varieties have been made, looking toward high yielding first generation strains possessing other desirable qualities, but up to the present none has proven as productive as the Cocke's Prolific×Yellow Creole cross mentioned above.

In 1932, Hugo Stoneberg, local corn breeder for the Bureau of Plant Industry, U. S. Department of Agriculture, began experiments in the production of a yellow strain of Cocke Prolific, utilizing the yellow color from Yellow Creole corn. Cocke Prolific and Yellow Creole were crossed and then in order to concentrate the Cocke Prolific "blood" the hybrid was backcrossed to the Cocke Prolific parent two or three times, each year planting only the yellow kernels from the hybrid strains. After the series of back-crosses is completed, selfing is required to fix the yellow color. Up to the present, the various back-crossed generations have yielded about as well as the Cocke Prolific parent.

Corn Breeding by Inbreeding Methods. Corn breeding by selecting in inbred lines and crossing certain of the inbred strains has consistently given increased yields over other methods of corn breeding used in the Corn Belt States. In 1923, the Division of Cereal Investigations, U. S. Department of Agriculture, Hugo Stoneberg in charge, started inbreeding corn at Baton Rouge in co-operation with the Louisiana Experiment Station. Most of the strains with which the work was started proved to be unsuited to Louisiana and no outstanding crosses were secured during the earlier years.

In 1926, work was started with Cocke's Prolific, Whatley, Hasting's, Mosby, Delta Prolific, and Creole. These were among the best local varieties and since 1926, much better progress has been made. Each year many plants have been inbred by self-pollination and several hundred inbred strains produced. These are tested and many of the weaker and undesirable strains discarded. Only the strong sturdy strains having a good stalk, good root systems, a prolific tendency, and ample husk protection for the ear are saved. The strains that are saved are crossed in various combinations and first generation strains grown. All of these crossed strains are much more vigorous and better yielders than their inbred parents and some have given indications of being better yielders than the original varieties with which the work was started.

The various crosses made in this corn breeding work have been called "single crosses," "double crosses," "top crosses," and "synthetic varieties." The "single cross" is simply the first generation, or F_1, hybrid between two inbred lines. Single crosses yield well but they are not of much immediate practical value because present inbred strains are low yielding and as the crossed seed must be produced on one of the lines, the yield of seed usually is small and therefore too expensive to be used in practical corn growing. This difficulty is avoided by making what is known as a "double cross." This is produced by crossing two productive single crosses. The double cross strains are no more vigorous and they yield little, if any, better than the single crosses. Their main advantage lies in the fact that the crossed seed may be produced more economically and sold more cheaply. "Top crosses" are crosses between an inbred strain and an ordinary open-pollinated variety. The crossing usually is accomplished by planting the two in alternate rows and detasseling the inbred strain. All of its plants are thus cross pollinated. The crossed seed thus produced is tested in yield tests the following year. By this means it is possible to get some measure of the comparative merits of a large number of inbred lines because a number can be crossed in one field without the labor of hand pollination. On the basis of yield tests over a period of years, the better lines can be determined and used in single and double crosses. The main value of top crosses is in determining merits of different inbred lines, but since they have yielded well in tests when compared with commercial varieties, it is possible that they may have some value as commercial hybrids. "Synthetic varieties" are produced by mixing the seed of the better inbred lines and allowing them to inter-pollinate.

During the years 1935 and 1936, some of the hybrid strains produced in the breeding plots yielded 25 per cent more than Cocke's Prolific. These results look promising. However, more tests at various localities in the State are necessary to determine the practicality of this method of corn breeding in Louisiana. (The Experiment Station has no hybrid seed corn for distribution.)

Plant Characteristics Which Should Guide in Selection Work. Some years ago it was thought that an ideal corn stalk should have low ears, medium long husks, rough kernels, deep kernels, and a medium short shank. Subsequent research showed that selecting for some of these characters tended to reduce yields. It was found, for instance, that strains with smooth ears would produce more corn than rough-ear strains, and that shallow-kernel strains would produce more than deep-kernel ones. Since most of this testing was done in the North, it was thought that it might be worthwhile to see if the same held true for southern varieties, and whether we are making a mistake in selecting for low ears, long husks, short ear shanks, and two-ear stalks. To determine this, high and low ear, long and short husk, rough and smooth kernel, deep and shallow kernels, long and short shank, and one and two ear selections were made and the selections having the contrasted pairs of characters planted in replicated alternate plats for testing yields and certain other features. Table XII gives the plot yields in pounds of ear corn for a three-year period. Some of the results do not appear to be very consistent, but some indications are shown. It will be necessary to run the experiment for a longer time to get more definite results.

TABLE XII. CORN SELECTION FOR PLANT CHARACTERISTICS

	1933 Pounds	*1934 Pounds*	*1935*		*1936 Pounds*
			Pounds	*Bushels per Acre*	
High Ear	207.6	123.3	476.0	61.8	204.7
Low Ear	176.9	159.6	453.5	58.9	232.4
Long Husk	285.6	166.0	321.9	43.8	165.2
Short Husk	296.2	136.7	306.5	41.7	158.3
Long Shank	182.2	143.1	184.5	59.8	.....
Short Shank	181.7	140.4	176.2	57.1	.....
One-Ear Selection	396.7	65.8	313.5	42.6	.....
Two-Ear Selection	437.5	95.6	333.4	45.3	.....
Smooth-Ear Selection	224.5	127.3	331.4	57.3	.....
Rough-Ear Selection	179.9	78.7	324.6	56.2	.....
Deep-Grain Selection	.....	117.3	177.6	57.5	.....
Shallow-Grain Selection	.....	101.6	191.2	61.9	.....

Date of Planting at Baton Rouge. This experiment was run to get data on the comparative yields of and insect damage to corn planted at various periods of the planting season. Yellow Creole corn was planted on medium fertile alluvial land on the dates shown in the table below. Otootan soybeans were planted in the corn. The experiment was run for the fourth year in 1936. Comparative yields and insect damage for the different planting dates have been much the same other years as in 1936. There seems to be no significant difference in yield from plantings made prior to June 1. After that date there is a rapid decrease in yields. Bud worms are much worse on March and April plantings than on others.

TABLE XIII. CORN DATE OF PLANTING EXPERIMENT, 1936

Date Planted	*Yield, Bushels per Acre*	*% Plants Killed by Bud Worms*	*% Plants with Cane Borers*	*% Plants with Corn Ear Worms*	*% Plants with Grain Weevils*	*% Smutty Ears*	*% Plants with Brown Leaf Spots, (Physoderma)*	*% Ears with Rots Other Than Smut*
February 25	56.2	9.2	25.9	73.0	24.9	0.18	25.4	1.1
March 12	55.3	29.4	22.9	43.2	16.0	0	29.4	1.5
March 29	59.1	17.0	21.7	23.4	16.6	0.67	27.7	4.2
April 13	46.1	.7	29.3	61.1	16.9	1.28	33.5	6.2
April 29	56.2	.2	55.4	90.9	5.9	1.11	26.7	8.5
May 15	58.2	0	74.0	85.7	3.0	1.5	1.2	8.9
June 1	44.3	0	81.6	86.2	2.8	3.6	3.1	11.4
June 17	20.2	0	84.4	84.1	22.96	9.0	.3	8.4
July 3	7.3	.3	100.0	79.4	57.2	15.3	0	3.0

Corn Spacing with Soybeans Planted in the Row. In 1929, corn spacing work was started on medium fertile alluvial land at Baton Rouge. In 1930, similar work was also started on bench land. Biloxi or Otootan soybeans were planted in the corn row when the corn was planted. Yellow Creole corn was planted on the alluvial land and Cocke's Prolific on the bench. In all instances, except those noted, 4-foot rows were used and spacings within the row were one stalk per hill at the distances specified in the tables. About 400 pounds per acre of a complete fertilizer was used on the bench land. In some years the stands were not satisfactory, making results unreliable. No report is made for such years.

The width of spacing for best results varies considerably, depending upon the fertility of the soil and the amount of moisture available. As the soil used in the tests reported was medium fertile and rainfall was moderate, close spacing gave best results, as a rule. A much wider spacing is needed on poorer land.

Tables XIV and XV give in some detail the results obtained.

Effect of Furrow, Level, and Ridge Planting on Corn Production at Baton Rouge. In 1929 an experiment was started to show that level culture would produce better corn yields than ridge culture. To the surprise of the experimentor, the ridge plats gave about 10 per cent better yields at harvest. Thinking that this might have been just accidental, the experiment was run again in 1930. This year the difference in the

TABLE XIV. CORN SPACING ON ALLUVIAL LAND

Spacing	Yield in Bushels per Acre					Five Year Average
	1929	1930	1931	1932	1933	
12 Inches	53.5	39.0	38.2	43.2	57.2	46.2
18 Inches	....	....	....	....	43.8	....
24 Inches	48.8	37.5	31.0	44.2	41.8	40.6
36 Inches	44.9	35.7	28.6	37.3	34.7	36.2
48 Inches	39.2	34.8	26.4	33.6	31.9	33.2

TABLE XV. CORN SPACING ON BENCH LAND

Spacing	Yield in Bushels per Acre						Six Year Average
	1931	1932	1933*	1934†	1935†	1936*	
12 Inches	22.8	49.5	33.9	12.5	17.4	26.1	27.0
18 Inches	....	....	36.8	15.9	19.2	28.3	25.1‡
24 Inches	19.6	45.7	38.7	14.9	22.7	28.6	28.4
36 Inches	16.3	36.7	35.8	12.4	19.7	24.4	24.2
48 Inches	14.8	29.2	....	....	....	....	....

*A 3½-foot row was used on the bench land in 1933 and 1936.
†Planting was made on poor land and weather was dry.
‡Four-year average.

appearance of the plants in the two sets of plots was striking, the plants on the ridge plots being a darker green color and more vigorous. At harvest the ears on the ridge plots looked larger and weighed 22 per cent more. It began to appear that we were showing ourselves something and plans were made for running the experiment for a longer time. Beginning in 1933, a duplicate experiment was run on alluvial land and furrow plantings were made in addition to the other two.

The rows used were four feet apart. The ridges were about 1 foot high when planting was done and were cultivated to maintain the ridge. The furrows used were about six inches below the level and were filled by throwing dirt to the corn in cultivation. Soybeans were planted in the rows on alluvial land but were not used on the bench land.

For a period of seven years, the ridge culture invariably gave better yields than the level, as may be seen in Tables XVI and XVII. In some years the margin of difference was not great enough to be significant, but in other years it showed clearly in the appearance of plants, and there was a considerable difference in yields. Preliminary studies have shown that the soil in the ridges is more porous and better aerated than the soil on the level plots. This may account for some of the difference in the early growth of plants. In all cases except one, the furrow planting also gave better yields than the level planting.

While it appears that ridge and furrow culture are better than level culture at Baton Rouge, it is not at all certain that they would be best in other places.

Effect of Soybeans on Corn Yields when Planted in the Corn Rows at the Time the Corn Is Planted. As a rule, soybeans growing in a row of corn tend to interfere with

TABLE XVI. YIELDS OF GRAIN ON BENCH LAND (Bushels per Acre)

Plots	*1929*		*1930*		*1931*		*1932*		*1933*	
	Bu.	*% Increase Over Level*	*Bu.*	*% Increase Over Level*	*Bu.*	*% Increase Over Level*	*Bu.*	*% Increase Over Level*	*Bu.*	*% Increase Over Level*
Level culture.....	58.8	....	26.9	....	37.0	....	41.6	....	36.8	....
Ridge culture.....	61.9	10.9	32.6	22.1	42.7	13.4	43.6	4.8	38.1	3.5
Furrow culture....	....	....	....	....	....	....	....	....	....	....

Continued.

Plots	*1933**		*1935*		*1936*	
	Bu.	*% Increase Over Level*	*Bu.*	*% Increase Over Level*	*Bu.*	*% Increase Over Level*
Level culture.......	30.9	....	43.8	....	17.4	....
Ridge culture.......	33.7	9.1	48.9	19.5	20.2	16.1
Furrow culture......	....	....	40.4	– 7.7	20.6	18.4

*A duplicate test on bench land was run in 1933.

TABLE XVII. YIELDS OF GRAIN ON ALLUVIAL LAND (Bushels per Acre)

Plots	*1934*		*1935*		*1936*	
	Bu.	*% Increase Over Level*	*Bu.*	*% Increase Over Level*	*Bu.*	*% Increase Over Level*
Level culture.......	30.7	....	36.9	....	29.7	....
Ridge culture.......	33.9	10.7	44.2	19.5	33.4	12.2
Furrow culture......	35.0	14.1	37.8	2.4	33.3	12.0

its growth somewhat like weeds do when growing in the row. The heavier the growth of the bean vines, the poorer the soil, and the scarcer the supply of moisture in the soil, the more harm the beans do to the current crop. However, the harm that a heavy growth of beans does to a particular crop may be offset by the help they give a succeeding one.

Experiments to determine the effect of soybeans in corn were started on bench land soil in 1929 and conducted on the same plots for five years. Cocke's Prolific corn and Otootan soybeans were used and all the bean vines and corn stalks were turned back into the soil. Fifty pounds of nitrate of soda, 300 pounds of superphosphate, and 50 pounds of muriate of potash per acre were applied each year before planting.

In Table XVIII, comparison with the figures from plats growing corn alone will show that soybeans in the corn row reduced yields considerably the first two years. After that time, however, the soil-renovating effect of the beans began to show; the plats with beans made the better yields of corn grain, and the corn stover was also heavier. A part of the profit from growing the beans was had in the soil enrichment, or in the soybean hay or seed that could have been harvested.

TABLE XVIII. EFFECT OF SOYBEANS ON CORN PRODUCTION WHEN PLANTED IN ROW WITH THE CORN

Year	*Bushels Corn on "Corn Alone" Plots*	*Bushels Corn on "Corn and Bean" Plots*	*Bean Hay per Acre on "Corn and Bean" Plots*	*Corn Stover on "Corn Alone" Plots*	*Corn Stover on "Corn and Bean" Plots*	*% Gain or Loss from the Use of Soybeans*
1929	41.9	28.0	4020#	....	....	−19.1
1930	40.7	25.9	2736	....	....	−33.6
1931	19.6	22.1	....	....	....	+12.7
1932	26.7	40.5	3478	....	....	+51.7
1933	24.4	33.0	2200	8800#	11600#	+35.2

FIGURE 3. COTTON AFTER CORN AND SOYBEANS.

(Further data on the effect of soybeans on corn yields are given in Louisiana Bulletin No. 265.)

Effect of Soybeans on Corn Yields when Planted in the Same and in Alternate Rows. This experiment was conducted during the same years and on plots adjacent to those on which the experiment mentioned above was conducted. Soil, fertilizer, weather conditions, and varieties were about the same in the two experiments. In the alternate row experiment, two sets of four plats each were used. There were three rows of beans and three rows of corn in each plat of one set, and six rows of corn with beans in all of the rows in each plat of the other set. The same amount of seed of corn or of soybeans that was planted in three rows in one case was planted in six rows in the other. When thinning the corn, an effort was made to preserve the same ratio. The beans were not thinned. The plats were rotated each year.

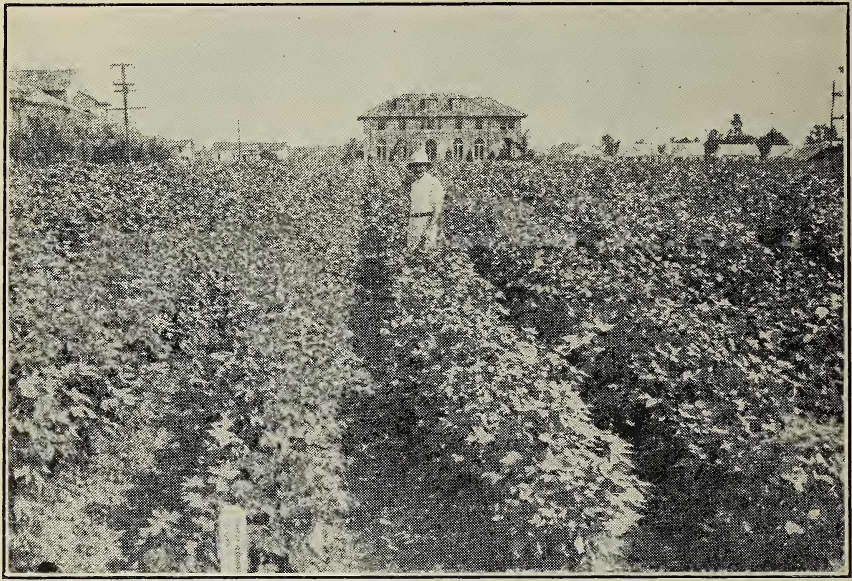

FIGURE 4. COTTON AFTER CORN IN WHICH THERE WERE NO SOYBEANS.

Table XIX gives data on the yields following the two methods of planting. It will be observed that in every instance except one, the every-row planting gave the best corn grain yields. The one year that the alternate row plats led, 1930, was a dry one in which growth conditions were not good. Although the evidence is not very conclusive, it appears that the alternate row planting may be more satisfactory under less favorable conditions. This accords with the views of farmers in poor land areas and in regions where droughts are common. There seemed to be no significant difference in yield of soybean hay following the two methods of planting.

Effect of Rate of Soybean Seeding in Corn on the Production of Corn Grain, Corn Stover, and Soybean Vines. It is the consensus of opinion that increasing the rate of seeding soybeans in corn will result in decreased corn yields. Experiments were

TABLE XIX. DATA ON THE EFFECT OF PLANTING CORN AND SOYBEANS IN THE SAME AND IN ALTERNATE ROWS

Year	*Bushels Corn, Alternate Row Plots*	*Bushels Corn, "Every Row" Plots*	*Bean Hay, Alternate Row Plots*	*Bean Hay, "Every Row" Plots*	*Corn Stover, Alternate Row Plots*	*Corn Stover, "Every Row" Plots*
1929	36.6	40.7	3777#	3982#	.....	......
1930	18.1	15.8	2971	3097	......	......
1931	19.1	21.1	....	....	......	......
1932	32.3	40.9	3025	2423	......	......
1933	22.6	26.3	1833	1956	8433#	10037#
Aver.	25.7	28.9	2803	2679	......	......

conducted for a five-year period to get data on this question. The experiments were conducted under conditions similar to the other local experiments discussed above, except that they were planted on rather fertile Mississippi River alluvial land, and Yellow Creole corn was used. A rate of seeding of 10, 15, and 20 pounds per acre of Otootan soybeans was used. The soybeans were planted in the corn rows when the corn was planted. They made good growth, covering the middles between rows completely.

From the data given in Table XX, it appears that the variation in rate of seeding used was not sufficient to make any significant difference in yield of corn grain or corn stover.

TABLE XX. EFFECT OF RATE OF SEEDING SOYBEANS IN CORN

Rate of Seeding	*Year*	*Bushels Corn per Acre*	*Pounds Corn Stover per Acre*	*Pounds Soybean Vines per Acre*
Ten pounds beans per acre	1929	63.0	......	15,400
	1930	48.4	......	17,000
	1931	63.9	23,656	7,000
	1932	....	20,460	12,899
	1933	72.3	23,980	7,752
	Average	61.9	22,699	12,010
Fifteen pounds beans per acre	1929	63.7	......	14,550
	1930	44.5	......	18,632
	1931	59.6	24,187	10,070
	1932	....	20,900	13,688
	1933	67.6	21,418	9,656
	Average	58.8	22,168	13,315
Twenty pounds beans per acre	1929	62.1	......	13,750
	1930	46.1	......	19,312
	1931	58.7	23,843	12,800
	1932	....	19,910	14,713
	1933	65.9	23,489	8,840
	Average	58.2	22,414	13,883

Effect of Soybeans on the Following Crop of Corn when the Beans Are Cut for Hay or when Plowed Under. Only a limited amount of work has been done to determine the effect of soybeans on the following crop when cut off for hay, or when plowed under. Most of the experiments that have been conducted showed that if the beans were cut for hay, about 50 per cent as much benefit would be obtained as when turned under. Local experiments to get data on this question were started on bench land soil at Baton Rouge in 1929. The general conditions of the experiment were similar to conditions for other corn and soybean experiments discussed above. Twenty one-row plots were used for each of three treatments—corn alone, soybeans turned under, and soybeans cut for hay. In 1929, 4263 pounds of hay per acre were grown on the bean plats. In 1930 all the plots were planted in corn, and in 1931 beans were again planted on a part of the plots, and so on, a two-year rotation being followed. After 1931, the corn-alone plots were allowed to lie fallow when the other plots were in beans. In 1934 all the plots were damaged by a tropical storm in June, and in 1936 the weather was too dry for good corn production. Table XXI gives the relative yields following the different treatments. It may be seen that the beans gave large and consistent increase in yields and that turning the beans under gave about twice the benefit that growing them for hay gave.

TABLE XXI. CORN YIELDS AFTER SOYBEANS WERE TURNED UNDER OR CUT FOR HAY

Year	*Plots with Beans Turned Under*		*Plots with Beans Cut Off for Hay*		*Plots that Grew no Beans*
	Bushels Corn per Acre	*% Gain from Beans*	*Bushels Corn per Acre*	*% Gain from Beans*	*Bushels Corn per Acre*
1930	30.5	55.6	24.1	22.9	19.6
1932	50.2	162.3	33.3	74.3	19.1
1934	21.0	98.1	19.5	83.9	10.6
1936	23.4	284.2	13.7	124.0	6.0

PART III

JOHN P. GRAY AND DAWSON M. JOHNS*

SOYBEANS

Soybean Varieties. Soybean variety tests have been conducted in Louisiana each year since 1929. During that time a large number of the leading commercial varieties have been tried on different soil types. Results from these tests show the relative yielding ability of the various varieties.

The soybeans grown in Louisiana are of two general types: the viney type, of which Otootan, Laredo, Barchet, and Louisiana Selection 108 are examples; and the upright or stiff-stem type, which includes Biloxi, Mammoth Yellow, Tokyo, Delsta, Mamloxi, and Looney-2. The varieties of the viney type have fine stems with numerous branches and rather small leaves. Having fine stems, they make a better quality of hay; and, since the vines cover the ground well, they are better to plant in corn to keep down grass and weeds after the corn is laid by. The beans of the upright type have coarser, more woody stems, and large leaves. They make a poorer quality of hay, but are more easily harvested with machinery and, as a rule, produce more seed than the other type. The Otootan has led in hay yields in most tests that have been conducted in the State. Seed yields have usually been low due to the damage caused by insects. Of the older varieties, Tokyo, Looney-2, and Mamloxi made the best seed yields in 1935 and 1936.

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* J. P. Gray collected most of the data given. D. M. Johns prepared the discussion and collected data in 1936.

The Avoyelles, U. S. Selection 71570, and Palmetto are three new varieties that give promise of value for Louisiana. They are of a semi-viney type, make nearly as much hay as the Otootan, and the quality of the hay is good. Their seed yields in 1935 and 1936 were excellent—better than those of any other varieties grown. The Avoyelles has black seeds. The other two new varieties have yellow seeds, which make them satisfactory for growing for oil production.

Table XXII gives the hay and seed yields on bench land at Baton Rouge and the average hay yields in State tests, expressed in percentage of Otootan hay yields in the same tests.

TABLE XXII. SOYBEAN VARIETY TESTS

Variety	*State Average Hay, % of Otootan*	*Bench Land—Baton Rouge*					
		Years in Test	*Cured Hay Pounds per Acre*		*Hay, % of Otootan*	*Seed per Acre, Bushels*	
			Av. 1929-36	*1936*		*1935*	*1936*
Otootan	100	8	6314	6572	100	8	0
Avoyelles	92	2	6183	6300	92	22	3
Biloxi	89	8	5123	5795	81	11	3
Mamloxi	77	4	4377	4006	68	14	6
Delsta	80	4	4847	5134	72	10	9
Delnoshat	75	2	4866	5172	70	..	3
Tokyo	88	7	4209	5639	68	16	6
U. S. 71570	89	2	6191	5912	92	23*	10
Chiquita	76	2	4832	5484	72	10*	8
Looney—2	76	3	4930	5911	75	20	8

*Newer Strains Test.

Edible Soybeans. All varieties of soybeans may be cooked and eaten as table food, but certain varieties such as Easycook, Rokusun, and Hahto are the most satisfactory. They are earlier and more productive than some other varieties and the beans are more palatable. They may be eaten as a green vegetable or the dried beans may be used. They are cooked and seasoned like ordinary garden beans. The green beans can be shelled more easily after the pods have been placed in boiling water for about three minutes.

Soybeans are richer in fats and proteins and lower in carbohydrates than other beans and peas.

SOYBEAN CULTURE

Width of Rows. Otootan soybeans were planted in plats with rows varying in width from 1 foot to 8 feet. Broadcast plots were also included for comparison. The yield of hay increased as the width of rows decreased from 8 feet to 2 feet. The difference in yield between the 2-foot, 1-foot, and broadcast plats was very small. A much better quality of hay was produced on the narrower rows. The diameter of stalk, height of plant, and number of branches per plant decreased as the width of row decreased, including the broadcast plot. In general, the 2-foot rows gave best results for hay production. Rows of this width permitted plowing to keep down the weeds. With the closer spacing, this could not be done economically.

Down to the 3-foot spacing, the yield of seed increased as the width of row decreased. The difference in yield between the 3-foot and 2-foot rows was not significant, however. The seed yields were considerably lower on the 1-foot rows and broadcast plot. For seed production, rows 3 feet apart seem most desirable. Fewer seeds are required for planting and less time is required for cultivation.

TABLE XXIII. YIELDS FROM VARIOUS ROW WIDTHS

Width of Rows	*1931*		*1932*		*1933*		*1934*		*4-Year Average*	
	Hay, lbs. per Acre	*Seed, Bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*
8 feet	3363	5.4	4261	6.5	4104	1.9	4065	7.1	3948	5.2
6 feet	4280	6.5	5917	8.1	5030	3.7	5290	9.7	5129	7.0
4 feet	4982	8.1	6045	8.2	5950	2.8	6068	9.9	5761	7.3
3 feet	5537	10.8	6570	9.2	6483	3.2	6119	12.1	6177	8.8
2 feet	6643	10.4	7569	11.4	7079	1.7	7157	9.5	7112	8.3
1 foot	6863	9.3	7939	6.9	5524	.8	8282	7.8	7152	6.2
Broadcast	5745	9.4	7906	7.2	6114	3.3	8826	6.0	7148	6.5

Rate of Seeding. The quantity of seed required to plant an acre varies with the size of the seed. A much greater weight of large seed is required to plant a given area than is required to plant the same area with small seed. The Biloxi, one of the large-seeded varieties, and Otootan, one of the small-seeded ones, were tried in a Rate of Seeding experiment which began with 5 pounds per acre and increased by 10-pound increments to and including 60 pounds. The Biloxi produced the highest yield of hay with a seeding of 30 pounds per acre. The Otootan also produced the highest yield of hay at the 30-pound rate, but a good yield was produced with the 10-pound seeding. The difference in the hay yield of the Otootan was not sufficient to offset the cost of the additional seeding.

Seed yields of both varieties did not vary a great deal with rate of seeding. The 20-pound rate is sufficient for seed production.

Date of Planting. The soybean can be planted over a rather wide range of dates, due to its ability to withstand the cold weather in late spring and hot weather in the summer. Experimental plantings were made of the Biloxi and Louisiana Selection 60 at 15-day intervals from March 5 to August 10. The highest yield of hay was secured from the March 17 planting. Good yields were secured from all plantings made before July 1; however, there was some falling off in yields from plantings made after April 27. Differences in seed yields from plantings made after March 15 and before June 15 were not significant.

Soybeans may be planted any time after the danger of frost is past. However, when grown alone, especially for seed production, less cultivation is required if extremely early planting is not practiced.

Table XXIV. Rate of Seeding Soybeans

Rate per Acre	*1931*		*1932*		*1933*		*1934*		*4-Year Average*	
	Hay, lbs. per Acre	*Seed, Bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*
Biloxi										
5 pounds	4057	5.1	3758	3.6	3462	.9	3345	1.9	3656	2.9
10 pounds	4738	9.1	3948	3.2	3929	.9	4512	4.5	4282	4.4
20 pounds	5065	10.9	3867	6.4	4201	.9	4474	6.9	4402	6.3
30 pounds	5746	10.9	5174	6.8	4357	.9	5446	8.9	5181	6.9
40 pounds	5174	10.2	4684	4.1	5096	.9	5329	6.5	5071	5.4
50 pounds	5201	10.5	5147	4.1	4824	.9	5252	7.3	5106	5.7
60 pounds	5174	12.9	4656	6.4	4746	.9	5563	8.4	5035	7.2
Otootan										
5 pounds	4684	4.9	4901	9.1	4590	1.1	5018	6.9	4798	5.5
10 pounds	4956	8.5	5364	8.2	4668	1.3	5679	6.3	5148	6.1
20 pounds	5010	8.5	5773	11.8	5135	.9	5496	9.9	5353	7.8
30 pounds	5058	8.1	5963	12.3	5213	1.1	5913	9.3	5425	7.7
40 pounds	4956	8.3	5501	9.5	4746	.9	5718	13.6	5230	8.1
50 pounds	4793	6.6	5746	10.0	4824	1.1	5252	10.8	5154	7.1
60 pounds	4956	6.8	5609	10.9	5057	.9	4979	9.3	5050	4.0

Grazing. Preliminary tests indicate that soybeans may give profitable returns when grown for grazing purposes. Ootootan soybeans were cut at various heights to find the closest grazing that the plants would survive. A high percentage of the plants died when cut below the lowest leaf. Only a few of the plants failed to make new growth when the plants were cut at a height of 7 to 10 inches, and sufficient growth was produced within three to four weeks for another grazing. Plants with only the top leaves removed required still less time. After the second cutting, plants cut within 7 to 10 inches of the ground produced sufficient growth for a third grazing. Consecutive plantings made at different dates during the spring and summer will provide for continued grazing.

Inoculation. It is not necessary to inoculate soybean seed when they are planted on land which has grown soybeans in a crop rotation, according to soybean inoculation tests conducted in 1935 and 1936.

Table XXVI shows no significant difference between plats in the yield of hay or seed. The inoculation of soybean seed is necessary when they are to be planted on land which has not previously grown soybeans. Inoculation may be accomplished by the use of pure cultures sold by seed dealers, or by the use of soil from a field which has grown soybeans. Both methods give good results.

(Additional data on soybeans may be found in a soybean bulletin to be published in the near future.)

COWPEAS

Formerly, cowpeas were used extensively in Louisiana for hay and for soil improvement. They would make good growth in corn when planted when the corn was laid by, and they made a quick hay crop when planted alone. The seed could be

TABLE XXV. DATE OF SEEDING SOYBEANS

Date of Planting	*1931*		*1932*		*1933*		*1934*		*4-Year Average*	
	Hay, lbs. per Acre	*Seed, Bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*	*Hay, lbs. per Acre*	*Seed, bus. per Acre*
Biloxi										
March 5	5641	1.3	5855	5.4	....	....	....	....	5748*	3.4†
March 17	6454	4.7	5664	4.8	....	....	5349	2.8	5822*	4.1†
April 6	6353	4.7	5228	4.8	6127	.5	6360	5.9	6012	4.0
April 27	5997	5.5	6045	4.2	5213	.4	5602	10.2	5714	5.1
May 18	5692	6.4	5174	4.3	3482	.5	4532	6.8	4720	4.5
June 8	6149	9.3	3594	3.6	2256	.9	3948	10.4	3987	6.1
June 29	4752	8.9	1525	....	3287	1.1	2606	5.4	3043	5.1*
July 20	2694	7.0	1416	....	1945	....	1556	5.6	1904	6.3†
August 10	1779	2.9	....	....	....	....	1206	....	1493†	2.9‡
Louisiana Section 60										
March 5	6607	2.4	6508	6.7	....	....	....	....	6558†	4.5†
March 17	6759	4.3	7298	5.4	....	....	5738	23.8	6598*	11.2†
April 6	6607	5.4	5582	5.5	6730	.7	5660	26.8	6144	9.6
April 27	6759	6.9	5664	4.7	6730	.8	4376	20.0	5882	8.1
May 18	7242	6.8	4983	4.8	4318	1.6	3618	24.0	5040	9.3
June 8	8182	11.0	3676	4.2	2879	1.0	3696	26.6	4608	10.7
June 29	6124	8.7	1879	3.6	4143	2.7	3054	14.0	3800	7.3
July 20	3650	7.3	1607	3.0	2490	.9	1712	....	2365	3.7*
August 10	2287	3.0	....	....	....	....	1167	....	1727†	3.0*

*3-Year average.
†2-Year average.
‡1-Year average.

TABLE XXVI. SOYBEAN INOCULATION TEST

Treatment	*1935*		*1936*		*Average*	
	Hay lbs. per Acre	*Seed bus. per Acre*	*Hay lbs. per Acre*	*Seed bus. per Acre*	*Hay lbs. per Acre*	*Seed bus. per Acre*
Inoculation— Soybeans not grown year before*	4123	19.6	5134	12.6	4628	16.1
No Inoculation— Soybeans not grown year before	4046	19.4	5056	11.3	4551	15.4
Inoculation— Soybeans grown year before	4046	17.7	4123	13.6	4085	15.7
No Inoculation— Soybeans grown year before	4357	18.2	4356	13.3	4357	15.8

*The plots that had not grown soybeans the year before did have soybeans on them two or three years previously.

gathered easily. The grower could get his planting seed without buying them and a part of the seed could be used as food.

More recently cowpeas have not been very satisfactory in parts of Louisiana, especially in the southern part, due to insect and fungous diseases that frequently attack the crop. It is difficult to combat these troubles. Planting wilt resistant varieties such as Iron and Brabham may help some, but results are frequently unsatisfactory.

LESPEDEZA

TABLE XXVII. HAY AND SEED YIELDS OF ANNUAL LESPEDEZAS

Variety	*Cured Hay Pounds per Acre*				*Seed per Acre—Pounds—1934*
	1932	*1933*	*1934*	*1932-1934 Average*	
Common	5572	3920	6142	5211	156
Tennessee 76	5127	4356	6349	5277	177
Kobe	5853	4283	6643	5593	137
Korean	3812	1742	3986	3180	38

Good yields were obtained from Common, Tenn. 76, and Kobe. Korean does not seem to be adapted to Louisiana. It matures in midsummer, and produces less hay than the other varieties and very few seed. Common produces a high quality of hay and remains green until late fall. The seed germinate later in the spring than Tenn. 76 and Kobe. The plants of Common are hardier than those of the other varieties, thus lessening the danger of being killed by late spring freezes.

If re-seeding is expected, the last cutting in the fall should be made after some of the seeds have matured and shattered, or the cutting should be made early enough to allow the new growth to produce seed.

Annual Lespedezas sown on a firm seedbed during late February or in March at the rate of 25 to 30 pounds per acre have given good results.

Lespedeza sericea. Lespedeza sericea is a perennial species of Lespedeza that is being introduced and tried experimentally in a number of southern states. It is somewhat like alfalfa in appearance and growth habits and can be grown on soils too acid for alfalfa. If the plants are cut at the right time and the hay handled properly, it is similar to alfalfa hay in value. If the cutting is delayed too long, however, the stems become too woody to make good hay, and if the hay is not cured partly in windrows, most of the leaves may be lost in moving it to barn or stack. Another drawback to the use of Lespedeza sericea as a hay plant is the difficulty of getting the young plants started. Unless they are cultivated the first year, grass and weeds may smother them out. This is especially true in parts of the State where the growth of grass and weeds is very rank.

Lespedeza sericea was grown experimentally at the Experiment Station from 1932 to 1936. It was planted in row and broadcast plots and given the following treatments the first year: hand weeded, weeds clipped, and weeds not removed. Weeds and grass were not removed from any of the plots after the first year.

For the first two years, the yield and the quality of hay from both the clipped and the not-weeded plots were comparatively low. In later years the plants on these plots outgrew the weeds and yielded better. Hand weeding is, of course, not a practical procedure in Louisiana.

Two or three cuttings per year were made. It was found that a close cutting late in the season had a tendency to kill many of the plants.

Table XXVIII shows the hay yields for a three-year period. It will be noted that the hay yields on all the plots were low the first year and rather low on some of them the second year. Except in regions where alfalfa cannot be grown, it seems doubtful that Lespedeza sericea will be a desirable crop.

TABLE XXVIII. HAY YIELDS OF LESPEDEZA SERICEA

Treatment	*1933 Tons per Acre*	*1934 Tons per Acre*	*1935 Tons per Acre*	*3 Year Average Tons per Acre*
L. sericea in drills—weeds removed by hand....	2.1	5.9	3.8	3.9
L. sericea in drills—weeds not removed........................	.24	.88	2.6	1.2
L. sericea in drills—weeds clipped...........................	.34	1.4	2.9	1.5
L. sericea broadcast—weeds removed by hand....................	2.0	6.6	5.4	4.7
L. sericea broadcast—weeds not removed........................	.49	1.7	6.3	2.6
L. sericea broadcast weeds clipped.............................	.56	3.7	5.4	3.2

ALFALFA

Excellent crops of alfalfa may be grown on the alluvial lands of south Louisiana and on similar land in other parts of the State. On much of the hill land of the State, however, alfalfa cannot be grown successfully without special soil treatment. In 1930 an experiment was started to determine the effect of certain soil treatments on alfalfa production on the Lintonia bench land soil at Baton Rouge. Hairy Peruvian alfalfa was planted October 6, and duplicate plots used.

Table XXIX gives various treatments used and yields for 1931 and 1932.

PEANUTS

For six years local peanut varieties have been grown in tests in comparison with 32 other varieties and strains introduced into the United States from foreign countries. Some of the new varieties, such as Coinage and San Jose, have produced good yields of both hay and nuts and appear promising under Louisiana conditions. The yields have varied from 2 to 4 tons of hay, with nuts attached, and from 25 to 80 bushels of nuts per acre.

Results indicate that peanuts may be grown profitably as a secondary crop in Louisiana, either for hay and seed or as a pasture crop for hogs.

TABLE XXIX. AVERAGE YIELD OF CURED ALFALFA HAY PER ACRE AND TREATMENTS USED

Rate of Application Pounds per Acre			*Hay—Pounds per Acre 1931*	*Hay—Pounds per Acre 1932*	*Average Pounds per Acre 1931-1932*	*Gain with Phosphate Added—Pounds*	*Gain with Additional Oyster Shell—Pounds*
Ground Oyster Shell	*16% Super-Phosphate*	*Muriate of Potash*					
Check	....	....	284	101	193	....	....
....	250	....	226	127	176	....	....
....	500	....	284	313	298	....	....
3000	....	....	3583	5942	4763	....	....
3000	250	....	3986	5923	4954	192	....
3000	500	....	4191	6262	5227	464	....
6000	....	....	4345	6462	5403	....	641
6000	250	....	4634	7010	5822	419	....
6000	500	....	4676	7287	5981	578	....
9000	....	....	4765	7056	5910	....	507
9000	250	....	4426	6946	5686	−225	....
9000	500	....	4316	6448	5382	−528	....
12000	250	....	4451	7636	6093	....	183
3000	....	125	3577	5409	4493	....	....
9000	250	125	4536	7593	6064	....	....

SORGHUMS

The sorghums fall into two groups, the grain sorghums which are grown principally for their grain, and the sweet sorghums or sorgos that have a smaller head of grain but much saccharine matter in the stalk, and heavier weight of stalks.

Date of planting and variety tests with sorghum have been conducted at Baton Rouge, St. Joseph, and Calhoun. The yields from various dates of planting depend largely upon the weather of the particular season. Sorghum will make good growth in Louisiana if planted after June 1. It can be planted much later than corn, and on land poorly adapted to corn. It is probable that sorghum might profitably replace some of the corn planted for feed in North Louisiana.

The best yielding sweet sorghums in the tests were Honey, Kansas Orange, Sapling (Saccaline), and Colman. Sumac and Red or Black Amber are earlier varieties. The best yielding grain sorghums were Shrock (Sagrain), Kafir, Hegari, Chiltex, Feterita, Milo, and Darso. Chiltex and Hegari were the earliest varieties grown.

FORAGE AND WINTER COVER CROPS

Winter cover crops should be planted early in the fall, to allow the plants time to develop a good root system before the winter freezes. Young tender plants with poorly developed root systems are more likely to be killed by occasional low temperatures.

In the winter crops test at Baton Rouge, 6 grasses, 17 clovers, 7 vetches, Austrian Winter Peas, and Tangier Peas have been grown to secure a comparison of their values as winter cover crops. The forage yields were obtained in the spring at the approximate time each crop should be turned under before a succeeding crop is planted. The green weight was taken for each crop and a 5-pound green sample was cured and weighed for a basis to calculate the cured forage per acre. Table XXX gives the yield in pounds of cured forage per acre of the various crops grown.

TABLE XXX. FORAGE AND WINTER COVER CROPS TEST

Variety	*Cured Hay Pounds per Acre*				
	1932	*1933*	*1934*	*1936*	*Average for Years Grown*
Orchard Grass	....	3703	....	....	....
Red-top Grass	....	3519	....	....	....
Dallis Grass	3521	1862	....	....	2691
Centipede Grass	5853	....	....	....	....
Italian Rye Grass	2311	....	....	....	....
Canary Grass—Reed	....	7351	....	....	....
Southern Bur Clover	....	4911	....	4206	4558
California Bur Clover	....	....	....	6256	....
Tifton Bur Clover	....	5826	6011	5429	5755
McNeill Clover (Cluster)	....	5824	4043	....	4933
Manganese Clover	....	....	....	3496	....
Persian Clover	....	2906	6330	3692	4307
Crimson Clover	....	....	6125	5489	5807
Alsike Clover	3528	6365	4029	4280	4551
Ladino Clover	....	....	3839	3275	3557
White Clover	4593	4451	2891	3071	3752
Subterranean Clover	....	3839	4530	5897	4755
Tri. procumbens (Hop Clover)	....	4955	3893	....	4424
Tri- dubium (Hop Clover)	....	2515	3594	....	3054
Cluster Clover	....	....	1203	....	....
Mammoth Red Clover	5772	9293	....	....	7533
Black Medic	3631	3308	4329	2951	3555
Melilotus indica	....	....	3389	1531	2460
Austrian Winter Peas	....	2777	5401	2951	3709
Tangier Peas	3659	4288	4612	3872	4108
Hungarian Vetch	2975	2001*	5227	3016	3305
Hairy Vetch	....	3398	4996	3928	4081
Smooth Vetch	3255	3237*	5513	3868	3968
Common Oregon Vetch	2513	2071*	5268	3880	3433
Purple Vetch	3588	2882*	6583	4189	4313
Monantha Vetch	2294	2115*	4212	4515	3285
Wooly-pod Vetch	2776	1899*	6708	3030	3603

*1932 Dry weights were used to figure weight of cured hay.

Considerable variation occurred from year to year. Vetches are best suited for winter cover crops, but the results do not indicate that any one variety is best for all conditions. Some of the higher yielding varieties in South Louisiana are often killed in North Louisiana by occasional low temperatures.

Vetches that produce 2 to 3 tons of dry matter per acre add 150 to 200 pounds of nitrogen to the soil when turned under.

Hairy vetch is winter hardy and probably the most dependable of the vetches; however, it may grow very little during the winter and growth is slow during early spring. Wooly-pod vetch is closely related to Hairy, but not so winter hardy, and produces more growth during the winter and early spring. Hungarian vetch is subject to winter freezing, but is thought to be better adapted to wet, poorly drained soils than other vetches. Smooth and Purple vetches produced high yields but are not usually considered sufficiently winter hardy for general use.

Austrian Winter Peas, Tangier Peas, and some of the clovers have given very good results as winter cover crops, but are more sensitive to acid soils than the vetches. Tangier Peas produced the highest yields, but they are very susceptible to winter freezes. Austrian Winter Peas are most resistant to low temperatures and are grown very successfully in North Louisiana.

MISCELLANEOUS FORAGE AND GREEN MANURE CROPS

In addition to the work on the forage and soil improvement crops discussed above, a limited amount of experimental work has been done on Crotalaria and some other crops in which there was some interest.

Crotalaria. Crotalaria is an annual summer legume that is grown considerably in Florida and some other states for soil improvement. It has very little, if any, value as a forage crop. Two species are said to be of some value as feed but mules on the Experiment Station farm refused to eat them even when confined in a box stall for a day with nothing else to eat. Some species are considered poisonous to livestock.

Nine species of Crotalaria were grown in tests at Baton Rouge one or more years. All species were rather leafy, but varied a great deal in their type of growth. The species range from 2 to 15 feet in height. Crotalaria spectabilis produced more growth than any other species and seems to be the best for soil improvement. This species produced a five-year average of 21.8 tons of green matter per acre, which, according to analysis, added an average of 169 pounds of nitrogen to the soil when turned under

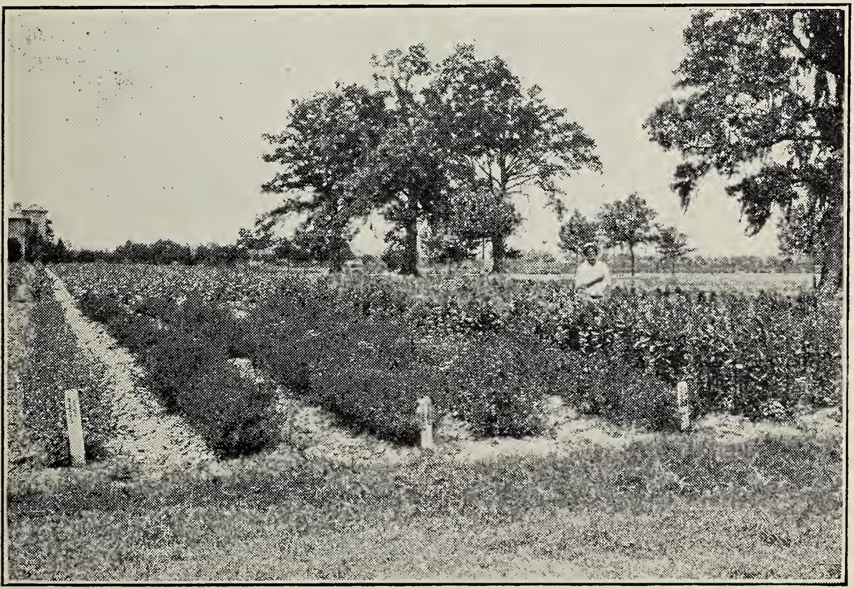

FIGURE 5. DIFFERENT SPECIES OF CROTALARIA. THE PLANTS WHERE THE MAN IS STANDING ARE CROTALARIA SPECTABILIS.

each year. The species striata and incana produced an average of 12.9 tons and 13.8 tons of green matter per acre, respectively, and when turned under, striata added 142 pounds and incana added 125 pounds of nitrogen. Other species grown were retusa, intermedia, maxillaris, grantiana, anagyroides, and goreensis. These varieties when turned under added from 48 to 109 pounds of nitrogen per acre.

Beggarweed. Beggarweed is a tall-growing annual legume grown to a limited extent for hay and soil improvement on some of the sandy lands of the coastal plain. The average yield on bench land at Baton Rouge for a three-year period was 14.7 tons of green matter per acre. This had a nitrogen content of 102 pounds per acre.

Velvet Beans. The Osceola velvet bean, one of the larger varieties, produced a three-year average yield of 17.1 tons of green matter per acre. This contained 212 pounds of nitrogen.

Sesbania (Coffee-weed). Sesbania, or Sesban, is a weed common on bottom lands in the extreme South. It makes a fairly heavy growth and contains about the same percentage of nitrogen as beggarweed. The yield on bench land was 14.7 tons of green matter per acre with a nitrogen content of 101 pounds.

Teosinte. Teosinte is a coarse annual grass that grows to a height of 8 to 12 feet. It is closely related to corn and will cross with it. It produces many stems from the same roots and can be cut for forage two times during the season. The forage has a feeding value similar to sorghum. The average yield on bench land at Baton Rouge for a three-year period was 28.7 tons of green matter per acre. Seed of Teosinte are scarce and expensive.

OATS

Variety tests with oats were conducted each year from 1931 to 1934 at Baton Rouge and at Calhoun, and in 1931 and 1932 at St. Joseph. These tests give information on the comparative yielding ability of the varieties when grown in different sections of the State. The highest yields were produced by the Red Rustproof varieties, such as Red Rustproof C. I. 1079, Thompson's Red Rustproof, Appler, Hastings 100 Bushels, and by the Fulghum strains. The Fulghum strains are 7 to 10 days earlier than the Red Rustproof varieties, but their yields are usually lower.

Conditions were very favorable for oats in 1931 and high yields were produced at the central station at Baton Rouge and at each of the branch stations. In 1931 the leading varieties produced 75 to 85 bushels per acre at Calhoun, 85 to 90 bushels at Baton Rouge, and 90 to 100 bushels at St. Joseph. Conditions, however, were much less favorable in 1932, 1933, and 1934, and the average yield was 10 to 20 bushels per acre both at Baton Rouge and at St. Joseph. These low yields were due principally to the crown rust disease. The rust diseases are more severe in South Louisiana than in the northern part of the State. Fair yields were produced at Calhoun each year. The Red Rustproof varieties planted there produced a four-year average of 50 to 58 bushels per acre.

The Red Rustproof varieties are rust resistant but they are not "rustproof." These varieties possess sufficient resistance to produce fair yields when the rust diseases are not very severe. The disease was so severe in 1932, 1933, and 1934 that oat production was unprofitable in South Louisiana with the varieties being grown.

The Experiment Station discontinued the oat variety test after 1934 and began a more extensive breeding program to develop varieties more resistant to the rust diseases. A good variety must be resistant to winter freezes and have the ability to produce high yields, in addition to being resistant to rust. The U. S. Department of Agriculture has introduced from other countries many varieties that are highly resistant to rust. These varieties are crossed with the higher yielding varieties of this country and selections are made for higher producing rust resistant strains. In co-operation with the U. S. Department of Agriculture, the Louisiana Experiment Station is testing a large number of these varieties and hybrid selections and making further selections in an effort to develop higher yielding, cold resistant, and rust resistant varieties adapted to Louisiana conditions. It seems that some progress has been made. At present the Country Common, Victoria, Bond, and Alber appear most promising. These varieties, however, are susceptible to freezing. Alber has produced a three-year average yield of 59.8 bushels per acre on bench land at Baton Rouge.

GROWING RICE ON DRY LAND

Some farmers that live in areas where the fields cannot be flooded conveniently are interested in growing a small amount of rice for home use. In 1932, in co-operation with Mr. Jenkins of the Rice Experiment Station at Crowley, a planting was made on bench land at Baton Rouge to test the feasibility of growing rice without water. The

TABLE XXXI. DRY LAND RICE VARIETY TEST

Variety	*Method of Planting*	*Width of Row—Feet*	*Yield of Rough Rice, Pounds per Acre*			*Average*		
						on Beds		*in Furrows*
			1932	*1933*	*1934*	*4-ft. Rows*	*2-ft. Rows*	*2-ft. Rows*
Honduras	on beds	4	479.2	827.6	620.7	643	....	....
	on beds	2	893.0	1698.8	1306.8	....	1300	....
	in furrows	2	718.7	1764.2	1089.0	....	....	1191
Fortuna	on beds	4	141.6	1100.0	239.6	494	....	....
	on beds	2	283.1	1764.2	326.7	....	791	....
	in furrows	2	217.8	1764.2	283.1	....	....	755
Vintula	on beds	4	468.3	1132.6	903.9	835	....	....
	on beds	2	936.5	1786.0	1502.8	....	1408	....
	in furrows	2	588.1	1611.7	1176.1	....	....	1125
Delitus	on beds	4	283.2	555.4	664.3	501	....	....
	on beds	2	522.7	1459.3	1263.2	....	1082	....
	in furrows	2	609.8	1807.7	1219.7	....	....	1212
Wataribune	on beds	4	305.0	827.6	631.6	588	....	....
	on beds	2	479.2	1372.1	1372.1	....	1075	....
	in furrows	2	392.0	1350.4	1219.7	....	....	987
Edith	on beds	4	......	653.4	773.2	713	....	....
	on beds	2	......	1197.9	1197.9	....	1198	....
	in furrows	2	.....	1306.8	849.4	....	....	1078
Shoemed	on beds	4	.....	1045.4	1023.7	1035	....	....
	on beds	2	.....	1720.6	1067.2	....	1394	....
	in furrows	2	.....	2069.1	958.3	....	....	1514

varieties named in the following table were planted on beds and in furrows in 2-foot and 4-foot rows, and cultivated enough to keep down grass and weeds. The planting dates were May 5, 1932, April 18, 1933, and April 26, 1934.

The yields given in Table XXXI show that a good crop of rice may be made without flooding, if given cultivation. The quality of the rice produced equalled that of rice grown under irrigation at Crowley.

SUNFLOWERS

Sunflowers were grown on both alluvial land and bench land at Baton Rouge in 1932 and 1933 to study their value as a crop for oil production. Two varieties were grown: Mammoth Russian and one designated as "Cuba."

The seeds were planted May 12, 1932, and April 19, 1933, in hills 12 inches apart in rows 4 feet apart. Later plants were thinned to one plant per hill. One head per plant was permitted to grow. Plants received the usual cultivation that corn is given.

The heads were cut when mature and threshed by hand to obtain the seed yields. On alluvial land, Mammoth Russian and Cuba produced an average of 49.1 bushels and 32.5 bushels per acre, respectively. Lower yields were secured on bench land.

Seeds of both varieties contain 11.0 per cent oil, by the cold press extraction method, based on weight of entire seed.

Yields were apparently reduced by insect damage, chiefly by one of the wood borers, *Hippopsis lemniscata*. The entire stalk was tunneled by the larvae, thereby stunting the growth of the plant, preventing normal development of the head, and causing the stalks to break off or lodge badly.

The extraction of oil from sunflower seed is an expensive process. For successful operation, a mill requires 60 tons of seed per day. With the development of other plant oil industries, it is doubtful that sunflower production for oil will become a profitable enterprise in Louisiana.

PART IV

F. L. Davis and H. C. Lovett

SOIL FERTILITY AND FERTILIZER INVESTIGATIONS

Cotton, Corn, and Soybean Rotation.

This rotation experiment has not run long enough for the full effects of the different rotations and treatments to show. However, some trends are apparent. There was a steady decrease in yield on land where corn was grown continuously without soybeans or fertilizer; where soybeans were planted with the corn, the level of production was maintained both with and without fertilizer. A winter cover crop of Hairy vetch has increased corn yields consistently, but the margin of increase has not been great. Where corn and soybeans were rotated with cotton, both when fertilized and when unfertilized, the yields of corn were lower than from continuous cropping to corn and soybeans. This is probably due to the fact that the cotton gets the main benefit from the soybeans.

Cotton in a fertilized rotation gives the largest yields; the unfertilized rotation next. The fertilized continuous cropping, the continuous cropping with a winter cover crop, and the continuous cotton without treatment, follow in yields in the order named.

TABLE XXXII. COTTON, CORN, AND SOYBEAN ROTATION ON LINTONIA SILT LOAM—BATON ROUGE

Plot No.	*Crop or Rotation*	*Fertilizer Treatment*†	*Yield of Corn—Bushels per Acre*					
			1932	*1933*	*1934*‡	*1935*	*1936*‡	*5-Year Average*
1*	Corn and soybeans, continuously	No fertilizer	29.3	31.7	16.2	48.2	26.5	30.8
3	Corn and soybeans, continuously	Fertilized	51.5	40.8	16.9	61.3	22.4	38.6
5&6	Cotton, corn and soybeans, rotation	No fertilizer	33.0	18.8	14.8	31.5	19.7	23.6
7&8	Cotton, corn and soybean rotation	Fertilized	48.7	29.8	17.0	50.8	24.7	34.2
9	Corn and soybeans with winter cover crop of hairy vetch, continuously	No fertilizer	33.7	34.9	17.6	53.8	22.9	32.6
11	Corn, continuously	No fertilizer	52.6	26.9	11.1	31.6	12.5	26.9
			Yield of Cotton Pounds Seed Cotton per Acre					
2	Cotton, continuously	No fertilizer	620	1117	768	1154	811	894
4	Cotton, continuously	Fertilized	515	1601	803	1661	1055	1126
5&6	Cotton, corn and soybean rotation	No fertilizer	677	1511	889	1747	1073	1179
7&8	Cotton, corn and soybean rotation	Fertilized	648	1708	861	1988	1187	1278
10	Cotton, continuously with winter cover crop of hairy vetch	No fertilizer	744	1427	847	1436	875	1066

*4 Replications or series of each plot.

†All fertilized plots received 600 pounds of a 5-8-4 fertilizer per acre annually.

‡Both corn and cotton were severely damaged by a tropical storm in June, 1934, and by dry weather in 1936.

Winter Cover Crops. In two experiments conducted for several years at Baton Rouge, the value of nine different winter cover crops has been compared to commercial inorganic nitrogen. Adequate quantities of phosphoric acid and potash have been applied annually to the cotton. The results indicate that the profit realized from turning under the various winter legumes before planting cotton is largely determined by the quantity of green matter turned under. In those instances in which the legumes failed to produce a growth of 3 tons or more of green matter per acre at the time of turning, they did not give as profitable increases in the yields of cotton as did applications of 36 pounds per acre of inorganic nitrogen. Austrian Winter peas, Hairy vetch, Hungarian vetch, Oregon-grown Common vetch, and Melilotus indica or "sour clover," have consistently given greater returns than has 36 pounds of mineral nitrogen per acre.

Residual Effect of Leguminous Green Manures. The growth of cotton obtained after plowing under leguminous winter cover crops for two or three consecutive years showed that it was not necessary to grow a green manure crop each year in order to maintain cotton yields at a high level on Lintonia silt loam. Consequently, they were not planted and the residual effects of those previously turned under were studied. The three-year average increase in yield of cotton from turning under vetch or Austrian Winter peas was 625 pounds per acre of seed cotton and from Melilotus indica it was 457 pounds. The application of 36 pounds of mineral nitrogen annually gave an average increase of 456 pounds of seed cotton per acre. In addition to the effect of legumes upon the crops immediately following them, the residue from the Melilotus indica increased the yields of cotton by 377 and 237 pounds of seed cotton per acre, respectively, the two following years. The average increase from the residue of the vetch or Austrian Winter peas amounted to 234 pounds per acre of seed cotton the first year and 190 pounds the second year. There was little or no residual effect from the applications of mineral nitrogen.

Adaptations of Winter Cover Crops. Of the winter legumes included in the tests, Hairy vetch, Hungarian vetch, Oregon vetch, Austrian Winter peas, and Melilotus indica have proved to be best adapted for green manure crops at Baton Rouge. Melilotus indica has been winter-killed once (the winter of 1932-33) since the fall of 1930. Although it has produced fair growth without lime, its response to lime at Baton Rouge shows that it is adapted only to neutral or very slightly acid soils. Liming of acid soils is necessary for successfully growing this crop.

The turning under of rye and oats has not economically increased the yield of cotton. Their value as winter cover crops depends upon their capacity for preventing soil erosion and for providing late winter or early spring grazing for livestock.

Under the conditions of these experiments, neither bur clover nor Persian clover has produced sufficient green organic matter to give maximum increases in yields of cotton.

Effect of the Date of Turning Under Soybeans on the Yield of Corn. Soybeans planted with corn were turned under on October 1, December 1, and March 1. No differences in the yield of corn were obtained as a result of the time of turning under the soybeans. Fall plowing was more effective in ridding the land of trash from crop residues. Incidentally, the test also showed that planting soybeans in the same rows with corn considerably reduces the yield of corn in very dry seasons.

FERTILIZER INVESTIGATIONS

Placement of Fertilizers. The object of this experiment was to determine the effect of the manner and placement of fertilizer in respect to the location of the seed upon the stand and yield of cotton. It was conducted cooperatively on Olivier silt loam at Baton Rouge for five consecutive years, 1931 to 1935, inclusive.

The fertilizer used was a 4-8-4 neutral fertilizer and all placements were made at planting time. They consisted of 14 different placements of the standard rate of application, which was 500 pounds per acre; three placements of one-half the standard rate, or 250 pounds per acre; and three of one and one-half times the standard rate, or

750 pounds per acre. Six replications of each treatment were made, being so divided that 12 stand counts and 12 yield weights could be recorded for each individual treatment.

Early in the season considerable differences in growth existed, but as the plants approached maturity these differences largely disappeared. Small but fairly consistent differences in yield were obtained from the different placements. Some placements definitely affected the stand.

The data indicate that the best results are obtained by placing the fertilizer as near as possible to the seed without seriously affecting the stand. An application of 250 to 500 pounds of fertilizer per acre is best placed in a band 1¾ inches wide located at a depth of from 2 to 3 inches directly below the seed, or 2 to 3 inches below and 1½ inches to the side of the seed; or it may be mixed with the soil to a depth of 3 inches under the seed. Applications as large as 750 pounds per acre are better placed 3 inches below the seed.

The Comparative Efficiency of Nitrogen from Various Sources. When applied with 48 pounds per acre each of phosphoric acid and potash, 30 pounds of nitrogen per acre from the following materials have given the following 10-year average yields of seed cotton on Lintonia silt loam at Baton Rouge: Nitrate of soda-potash, 1360 pounds per acre; nitrate of soda, 1355 pounds; a mixture of nitrate of soda and cottonseed meal, each supplying one-half of the nitrogen, 1309 pounds; a mixture with two-thirds of the nitrogen from nitrate of soda and one-third from sulphate of ammonia, 1294 pounds; calcium nitrate, 1278 pounds; 16-20 "Ammophos," 1239 pounds; Cyanamid, 1230 pounds; urea, 1226 pounds; and sulphate of ammonia, 1210 pounds. The plat not receiving nitrogen yielded 911 pounds of seed cotton per acre and the unfertilized plat, 839 pounds.

In another test on the same soil type in which phosphoric acid and potash were supplied at rates of 48 pounds per acre each, 30 pounds of nitrogen per acre from the following sources produced the following six-year average yields of seed cotton: Arcadian nitrate of soda, 1510 pounds per acre; nitrate of potash, 1480 pounds; Chilean nitrate of soda, 1472 pounds; ammonium nitrate, 1442 pounds; ammoniated superphosphate, 1327 pounds; and 11-48 "Ammophos," 1212 pounds. The plat receiving no nitrogen produced 1002 pounds of seed cotton per acre and the unfertilized plat, 967 pounds.

Source of Phosphorus for Cotton. In a 4-12-8 mixture applied at the rate of 600 pounds per acre at Crowley, various sources of phosphorus have given the following four-year average yields of cotton: basic slag, 1127 pounds of seed cotton per acre; bone meal, 1113 pounds; superphosphate, 1103 pounds; citratus, 1068 pounds; Ruhm's phosphate, 919 pounds; and rock phosphate, 843 pounds. The unfertilized plats yielded 225 pounds of seed cotton per acre and the no-phosphate plats, 244 pounds.

In 1936, the following phosphorus carriers, in applications of 600 pounds per acre of a 6-8-4 fertilizer, gave the following yields of cotton on Granada silt loam at Crowley: bone meal, 1111 pounds of seed cotton per acre; superphosphate, 1101 pounds; calcined phosphate, 1086 pounds; 11-48 "Ammophos," 1076 pounds; basic slag, 997 pounds; ammoniated superphosphate, 973 pounds; and ground raw rock phosphate, 597 pounds. The no-phosphate check plat produced 384 pounds of seed cotton per acre.

Rate of Nitrogen for Corn. On alluvial land at the Baton Rouge Station, each 16-pound increase in the amount of nitrogen applied per acre has given an increased yield of corn. Sixty-four pounds of nitrogen per acre was the largest amount used and has given a two-year average increase of 24 bushels of corn per acre.

Rate and Time of Applying Nitrate of Soda.[*] Field tests designed to determine the most profitable rate and date of applying nitrate of soda to corn, cotton, and oats, were conducted by F. A. Mitchell, graduate assistant, and the late Dr. A. H. Meyer, Associate Soil Technologist, at seven locations in the State.

Side application of 200 pounds of nitrate of soda per acre to corn when it was from knee to waist high gave slightly larger yields than did "bedding on" either at planting or two weeks before planting time.

Used with mineral fertilizers, 200 pounds of nitrate of soda per acre "bedded on" at the time of planting gave the most profitable yields of cotton. "Bedding on" two weeks before planting was intermediate and side-dressing the nitrate of soda after planting was the least profitable.

The rate of nitrogen test on oats indicated 200 pounds of nitrate of soda per acre to be, on the average, the most profitable application. From the first of February to the first of March was found to be the best period in which to apply nitrate of soda to oats. It was applied broadcast.

Rate of Potash for Cotton.[†] Tests designed to determine the most profitable rate of potash fertilization for cotton were conducted at Crowley, Mer Rouge, St. Joseph, Homer, Calhoun, Baton Rouge, and Lacassine. In fertilizer applications of 600 pounds per acre, 6 per cent potash gave the most profitable increases in yields at Crowley, 8 per cent at Homer, Calhoun, and Baton Rouge, and 12 per cent at Lacassine. Inclusion of potash in the fertilizer was not economical on the alluvial soils at either St. Joseph or Mer Rouge. Continuation of the tests for several years at Calhoun and Baton Rouge indicates 24 pounds of potash per acre to be sufficient for cotton when applied regularly each year. The results of the test at Calhoun further showed that applying the potash as a side-dressing gave larger increases in yields than did application at planting on deep sandy soils.

Fertilizer Analysis Tests with Corn. A limited number of fertilizer ratio tests with corn have shown that 30 pounds of nitrogen can in general be expected to give the best returns. Additions of phosphoric acid and potash have not been found profitable for corn.

Fertilizer Analysis Tests with Cotton. The general analysis tests with cotton have given in nearly all cases definite indications as to the fertilizer requirements of the various soils of the State. In these tests all fertilizers were applied before planting.

The tests on the Red and Mississippi river bottom lands have consistently shown that nitrogen is the primary limiting factor in the production of cotton. Thirty to 40 pounds of nitrogen per acre appears to be a satisfactory range in the amount to use, although increased yields have been obtained from as much as 72 pounds per acre at the St. Joseph Station. In these tests the profits from 30 to 40 pounds of nitrogen ranged from $4.00 to $21.68 per acre or from $2.33 to $6.16 per dollar invested in nitrogen. Potash has not been found to be necessary for the production of cotton on these soils, but 24 pounds of phosphoric acid per acre has been fairly definitely indicated as necessary for the largest yields on the older or long-used fields.

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[*] This work was supported in part by a fellowship grant made by the Chilean Nitrate Educational Bureau, Inc.

[†] This work was supported in part by a fellowship grant made by the N. V. Potash Export My., Inc.

The results of tests on the terrace or bench land soils of the Mississippi River have shown that from 30 to 40 pounds of nitrogen per acre gave the largest returns when phosphoric acid and potash were also supplied. All soils on which the tests have been conducted showed a definite need for phosphoric acids but the maximum profits per acre were consistently obtained from 24 pounds per acre. The response to potash varied and the amounts necessary for maximum profits varied from 24 to 48 pounds of potassium per acre. The larger applications of potash tended to be most profitable in seasons when conditions permitted late fruiting.

On the prairie soils of the southwestern part of the State, 24 to 30 pounds of nitrogen per acre have given the largest net profits when phosphoric acid and potash were also supplied. The tests also showed that 48 pounds of phosphoric acid and 48 pounds of potash were necessary for maximum yields. Applications of potash are important as a means of preventing cotton "rust" in this section of the State, and in areas in which cotton "rust" is excessive even larger applications than 48 pounds per acre have been profitable.

Under average conditions, 30 to 36 pounds per acre of nitrogen in the fertilizer have given the maximum net profits in the analysis tests conducted on the interior coastal plain or hill land of northern Louisiana. The tests have shown that cotton does not efficiently utilize the heavier applications of fertilizers on the very sandy soils when subjected to excessive drought. The phosphoric acid requirements of these soils ranged from 24 to 48 pounds per acre; the larger application, on the average, gave the largest returns. The potash required also ranged from 24 to 48 pounds per acre. The deep, sandier soils needed the heavier application.

(More details and recommendations based upon the results of the analysis tests will be published in the near future in bulletins now in preparation.)

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Fertilizers for Cotton on the Red and Mississippi River Alluvial Soils of Louisiana

By
H. C. LOVETT
AND
FRANKLIN L. DAVIS

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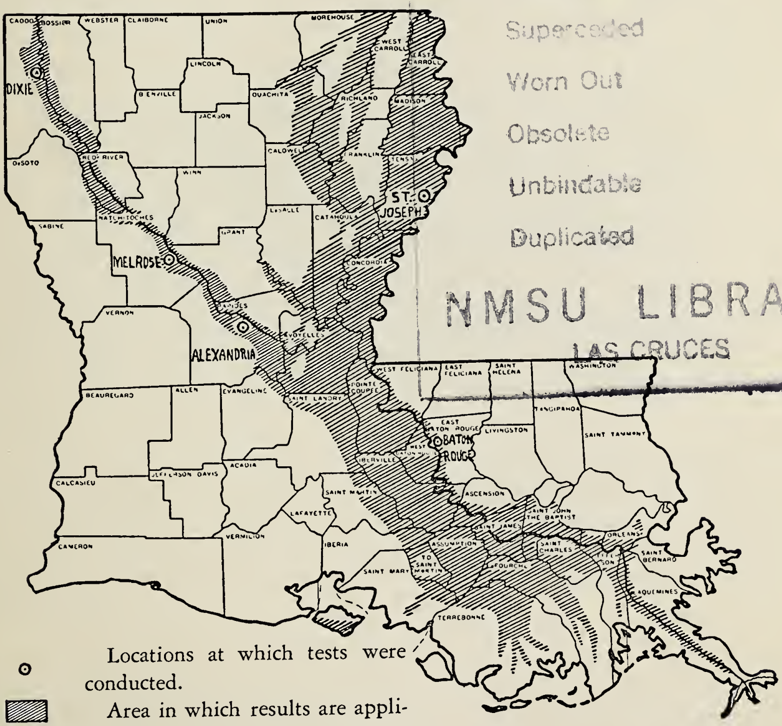

⊙ Locations at which tests were conducted.

▨ Area in which results are applicable.

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

STATEMENT

The test at St. Joseph has been conducted cooperatively by C. B. Haddon, Superintendent of the Northeast Louisiana Experiment Station. The Outfield tests have been conducted on the farms of A. M. Andries at Alexandria, J. H. Henry at Melrose, and W. H. North at Dixie, in cooperation with the County Agricultural Agents of the respective parishes. Members of the Department of Crops and Soils who have supervised or conducted the experiments have been H. B. Brown, John Gray, the late A. H. Meyer, John R. Cotton, H. C. Lovett, and Franklin L. Davis. The manuscript has been prepared by H. C. Lovett and Franklin L. Davis.

Fertilizers for Cotton on the Red and Mississippi River Alluvial Soils of Louisiana

BY
H. C. LOVETT
AND
FRANKLIN L. DAVIS

In a discussion of any soil-improving practice, such as the use of fertilizers, there is but one sound basis upon which the value of the practices can be measured, and that is profit. This is well demonstrated by the fact that only those practices that have proven profitable to the farmer have persisted and have widespread application. Even when the expressed purpose for soil-improvement measures is "to maintain soil fertility" or "to conserve the soil," the fundamental reason for following them can be only that they eventually produce profitable returns.

The average yield of cotton in Louisiana is approximately 200 pounds per acre of lint cotton.[1] There is no doubt that these yields can be profitably increased. This can be done by following soil-improving and conserving practices, such as rotating crops, turning under certain green legumes, and applying the right kinds and amounts of commercial fertilizers.

While not all of the fertilizer used in the state is applied to cotton, a consumption of nearly 106,000 tons[2] during the season of 1936 indicates a fairly large usage of fertilizers for cotton. Furthermore, inquiries from farmers and agricultural workers show that there is a good deal of interest in the analyses and rates of application of fertilizers best suited for cotton.

During the past ten years, the Experiment Station has conducted a series of fertilizer tests on cotton. In addition, tests have been conducted cooperatively with quite a number of farmers in the state and at each of the branch experiment stations. The results of the tests carried on each year have been given in the annual preliminary report of the Department of Crops and Soils. A summary of the results of all tests conducted on alluvial soils of the Red and Mississippi river bottoms or "Delta" is reported herein.

PLAN OF EXPERIMENTS

The fertilizer experiments were designed to determine the ratio or analyses of fertilizers best suited for the production of cotton. They also give some information as to the rate at which fertilizers may be profitably applied.

The tests were based upon a 5-8-4 analysis. These figures signify a composition of the fertilizer as follows: 5.0 per cent nitrogen (N), 8.0 per cent phosphoric acid (P_2O_5), and 4.0 per cent potash (K_2O). Within this basic analysis each of the fertilizing constituents was varied, one at a time. Thus, as shown in Table 1, the fertilizer applied to plats Nos. 1 to 5 contained 5 per cent of nitrogen and 4 per cent of potash, but different amounts of phosphoric acid. Similarly, plats Nos. 7 to 12 received varying amounts of nitrogen, with the phosphoric acid and potash constant, and plats Nos. 14 to 18 represented the potash series. Plats Nos. 6 and 13 were not fertilized.

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[1] Agricultural Statistics, 1936. Prepared by Yearbook Statistical Committee of the U. S. Department of Agriculture.

[2] Figure from the Department of Agriculture and Immigration, State of Louisiana.

The fertilizer was applied to the plats at a rate equivalent to 600 pounds per acre. The cotton was grown continuously on the same land in most instances, and the plats were located in the same places each successive year. No intervening crops were grown for the duration of the experiments.

Each plat consisted of two rows of sufficient length to provide one-fiftieth of an acre. The plats were separated from each other by an unfertilized border row. Each treatment was replicated four times in each test, the replications being arranged in a manner to minimize, as far as possible, the effects of any variations in the soil.

The fertilizer was distributed in the furrow and "bedded on" about two weeks before planting. The cotton was "chopped out" and cultivated according to the usual farm practices. In most instances, the cotton was picked two times, an attempt being made to get one-half of the crop at the first picking and the remainder at the second picking.

Description of Soils

The tests have been conducted at five different places and on four different types of alluvial soils. The locations of the tests and the area of the state to which the results are applicable are shown in the map on the cover.

At the Northeast Louisiana Experiment Station at St. Joseph the test was conducted on Sarpy very fine sandy loam soil and at Baton Rouge on Sharkey clay loam. These two soils represent the predominating series of alluvial soils along the Mississippi River. In general, the Sarpy series occurs on the higher locations and has a sandier and more porous subsoil. Both are dark gray or black in color.

At Alexandria the test was located on Miller very fine sandy loam and at both Melrose and Dixie, on Yahola very fine sandy loam. Soils of both these series are brownish red in color. They are the most extensive of the Red River alluvial soils. These soils are differentiated by their subsoils. The subsoil of the Yahola very fine sandy loam consists of layers of interbedded materials varying in texture from fine sand to very fine sandy clay; that of the Miller soils is more uniform and generally heavier in texture.

Most of the area of alluvial soils of the Red and Mississippi River bottom lands falls within these four series. Within the limits of soil texture and climatic conditions, these series are similar in crop adaptations and fertility. Their response to fertilization can be safely considered as representative of the area indicated in the cover map.

Discussion of Results

The average annual yields of seed cotton produced by the different fertilizer ratios at each of the tests are shown in Table 1. The annual net profit or loss resulting from the use of the fertilizers has been calculated and is given in Table 2. These figures may vary from year to year, depending upon the price of fertilizer and cotton.

TABLE 1. PLAT NUMBER, FERTILIZER TREATMENT, AND AVERAGE ANNUAL YIELDS PER ACRE OF SEED COTTON PRODUCED BY THE DIFFERENT FERTILIZER ANALYSES.

Plat No.	*Analysis of fertilizer applied at the rate of 600 pounds per acre**	*St. Joseph 7-year ave. 1930-1936*	*Baton Rouge 6-year ave. 1929-1935*	*Alexandria 5-year ave. 1932-1936*	*Melrose 4-year ave. 1929-1933*	*Dixie 3-year ove. 1927-1930*	*Average of all tests 25 years*
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1	5-0-4	1936	2145	1734	1220	1018	1611
2	5-4-4	2011	2199	1912	1245	1078	1689
3	5-8-4	2060	2113	1826	1207	1104	1662
4	5-12-4	2004	2153	1858	1262	1131	1682
5	5-16-4	2012	2191	1889	1288	1148	1706
6	0-0-0	1524	1989	1206	913	978	1322
7	0-8-4	1543	1844	1360	956	969	1334
8	3-8-4	1831	2098	1655	1142	1031	1551
9	4-8-4	1954	2082	1701	1176	1090	1601
10	5-8-4	1993	2125	1805	1199	1144	1653
11	6-8-4	2109	2154	1886	1327	1119	1719
12	7-8-4	2160	2205	2007	1391	1131	1779
13	0-0-0	1534	1872	1267	1002	892	1313
14	5-8-0	1924**	2192	1820	1250	1144	1666
15	5-8-2	1905**	2121	1799	1240	1083	1630
16	5-8-4	1870**	2132	1804	1259	1048	1623
17	5-8-6	1892**	2080	1795	1311	1103	1636
18	5-8-8	1915**	2136	1758	1235	1174	1644
19	5-0-0	——	2130***	1858†	1310‡	——	——

*Nitrate of soda was used as the source of nitrogen, superphosphate as the source of phosphoric acid, and muriate of potash as the source of potash, with the exception that sulphate of ammonia was used as the source of nitrogen in the test at Baton Rouge in 1933, 1934, and 1935.

**Average of six years only. The treatment on these plats was changed in 1936.

***Average of three years only. This treatment was not included in the test before 1933.

†Average of four years. This treatment was not included the first year of the test.

‡Yield in 1933 only.

TABLE 2. PLAT NUMBER, FERTILIZER TREATMENT, AND AVERAGE ANNUAL NET PROFIT OR LOSS PER ACRE FROM DIFFERENT FERTILIZER ANALYSES.*

Plat No.	*Analysis of fertilizer applied at the rate of 600 pounds per acre*	*St. Joseph 7-year ave. 1930-1936*	*Baton Rouge 6-year ave. 1929-1935*	*Alexandria 5-year ave. 1932-1936*	*Melrose 4-year ave. 1929-1933*	*Dixie 3-year ave. 1927-1930*	*Average of all tests 25 years*
1	5-0-4	$12.44	$4.72	$16.04	$ 6.64	$ -.52	$ 7.86
2	5-4-4	14.24	5.68	21.96	6.44	.68	9.80
3	5-8-4	15.00	1.04	17.32	3.72	.52	7.52
4	5-12-4	11.56	1.44	17.40	4.72	.40	7.10
5	5-16-4	10.68	1.70	17.44	4.56	-.12	6.85
6	0-0-0	——	——	——	——	——	——
7**	0-8-4	-.64	-3.48	3.72	-.08	1.36	.17
8**	3-8-4	9.08	4.88	13.72	5.56	2.04	7.06
9**	4-8-4	13.40	3.64	14.96	6.32	3.80	8.42
10**	5-8-4	14.36	4.76	18.52	6.64	5.36	9.93
11**	6-8-4	18.40	5.32	21.16	11.16	3.76	11.96
12**	7-8-4	19.84	6.76	25.40	13.12	3.64	13.75
13	0-0-0	——	——	——	——	——	——
14	5-8-0	10.40	5.04	17.92	6.28	2.96	8.52
15	5-8-2	9.22	1.78	16.66	5.46	.10	6.64
16	5-8-4	7.40	1.80	16.44	5.80	-1.72	5.94
17	5-8-6	7.86	-.70	15.66	7.46	.06	6.07
18	5-8-8	8.36	1.12	13.76	4.00	2.48	5.94

*The seed cotton was valued at 4c per pound, nitrate of soda at $32.00 per ton, 20% superphosphate at $20.00, and muriate of potash at $35.00.

**In calculating the profit or loss from the use of fertilizers on plats Nos. 7 to 12, inclusive, the cost of potash and phosphoric acid, with the exception of 24 pounds of P_2O_5 per acre on the tests at St. Joseph and Alexandria, were not included as they did not produce profitable increases in yields.

As shown in Table 1, increased yields of cotton were obtained in practically every case from the use of phosphate. The amount of the increase, however, varied from practically nothing at Melrose and Baton Rouge to as much as 178 pounds of seed cotton per acre at Alexandria. At Dixie it ranged from 60 to 130 pounds and at St. Joseph, from 68 to 124 pounds. These increases in yields are all relatively small. Data given in Table 2 show that the addition of phosphate to the fertilizer in plats Nos. 1 to 5 did not produce sufficient profits to be worthwhile at Baton Rouge, Melrose, and Dixie. On the other hand, 4 per cent of phosphoric acid in the fertilizers, or 24 pounds of P_2O_5 per acre, has given significant profits at both St. Joseph and Alexandria. These have amounted to $1.80 per acre at St. Joseph and $5.92 per acre at Alexandria. Expressed in another way, these profits represent returns of $2.50 per $1.00 invested at St. Joseph and $5.92 per $1.00 invested at Alexandria.

The average annual yields of cotton in these experiments were increased in all cases by application of nitrogen fertilizers. The response to gradually increasing applications of nitrogen is shown in particular by the yields of plats Nos. 7 to 12, inclusive. On all tests, with the exception of the one at Dixie, the largest increase in yield was obtained from the largest application of nitrogen. The maximum increases at each of the locations were 617 pounds per acre of seed cotton at St. Joseph, 361 pounds at Baton Rouge, 647 pounds at Alexandria, 435 pounds at Melrose, and 175 pounds at Dixie. The figures in Table 2 show the average annual net profit produced by each of the applications of nitrogen. At Dixie the most profitable increase in yield was obtained from 30 pounds per acre of nitrogen. All applications of nitrogen up to 42 pounds per acre, which was the maximum application made in these tests, increased both yield and profit at all of the other locations. The average annual profit from the use of nitrogen in these tests ranged from $4.00 per acre at Dixie to $21.68 per acre at Alexandria, with all tests averaging $13.90. These profits represent returns ranging from $2.33 per dollar invested at Dixie to $6.16 per dollar invested at Alexandria. The average return for all the tests was $4.25 per dollar spent for nitrogen fertilizers.

In no case did applications of potash increase the net returns per acre. In only three of twenty instances in which potash was included in the fertilizer (see plats Nos. 15 to 18) was the yield larger than when it was omitted (plat No. 14). The addition of potash to these soils apparently had a slightly depressing effect upon the yield of seed cotton.

From the results secured in these experiments, it is clear that nitrogen has considerable influence on the yields of cotton on all these soils. While increases in yields were obtained in nearly all cases from applications of phosphoric acid, the amount of the increase was insufficient, in most instances, to justify its use. It is interesting to note in this connection that soils that gave the largest responses to nitrogen also responded profitably to phosphoric acid. From 30 to 42 pounds of nitrogen per acre have given the most profitable increases in yields on all soils. This can be supplied by application of 200 pounds per acre of nitrogen-carrying fertilizers containing 15 to 20 per cent nitrogen. On soils in which the reserve supplies of available phosphorus are becoming depleted by cropping, quite profitable increases in yields will be obtained from the use of as much as 24 pounds of phosphoric acid per acre. This can be supplied by applications of 300 pounds per acre of a 12-8-0 mixture.

SUMMARY

The results of the cooperative cotton fertilizer tests conducted on the Red and Mississippi River alluvial soils from 1927 to 1936, inclusive, are reported.

When added to a combination of the other two fertilizing constituents, potash did not produce a profitable increase in yield in any of these tests. Additions of phosphate gave definitely profitable returns in two of the five tests.

The maximum application of nitrogen, i.e., 42 pounds per acre, produced the largest profits in all but one of the tests, in which 30 pounds of nitrogen per acre was the most profitable. Average annual profits from the use of nitrogen ranged from $4.00 to $21.68 per acre, with an average of $13.92 for all tests. This represents an average return of $4.25 per $1.00 spent for nitrogen fertilizers.

The area of the state in which the results of these tests are applicable is shown on a parish outline map of the state.

Recommendations are made for the fertilization of cotton in this area.

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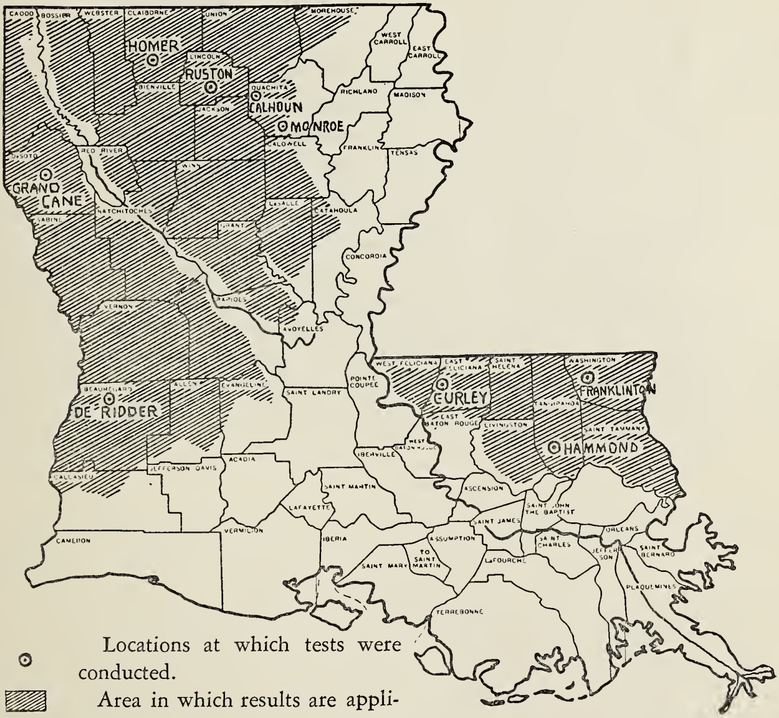
Louisiana Bulletin No. 285 April, 1937

Fertilizers for Cotton on the Coastal Plain Soils of Louisiana

By
FRANKLIN L. DAVIS
AND
H. C. LOVETT



⊙ Locations at which tests were conducted.

▨ Area in which results are applicable.

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

STATEMENT

The test at Calhoun was conducted cooperatively by Sidney Stewart, Superintendent of the North Louisiana Experiment Station. The Outfield tests were conducted on the farms of Atkins Bailey at Homer, Fred Croyer at DeRidder in 1930 and R. A. Bennett at DeRidder in 1932, 1933, and 1934, D. Glover at Ruston, E. G. Platt at Grand Cane, G. W. Benson at Hammond, G. L. Gayden at Gurley, N. W. McHenry at Monroe, and W. T. Magee at Franklinton, in cooperation with the County Agricultural Agents of the respective parishes. Members of the Department of Crops and Soils who have supervised or conducted the experiments have been H. B. Brown, John Gray, the late A. H. Meyer, John R. Cotton, H. C. Lovett, and Franklin L. Davis. The manuscript has been prepared by H. C. Lovett and Franklin L. Davis.

Fertilizers for Cotton on the Coastal Plain Soils of Louisiana

By FRANKLIN L. DAVIS and H. C. LOVETT

In a discussion of any soil-improving practices, such as the use of fertilizers, there is but one sound basis upon which the value of the practices can be measured, and that is profit. This is well demonstrated by the fact that only those practices that have proven profitable to the farmer have persisted and have widespread application. Even when the expressed purpose for soil-improvement measures is "to maintain soil fertility" or "to conserve the soil," the fundamental reason for following them is that they will eventually produce profitable returns.

The average yield of cotton in Louisiana is approximately 200 pounds of lint cotton per acre.[1] There is no doubt that these yields can be profitably increased. This can be done by following soil-improving and conserving practices such as rotating the crops grown and turning under certain green legumes, and by applying the right kinds and amounts of commercial fertilizers.

While not all of the fertilizer used in the state is applied to cotton, a consumption of close to 106,000 tons[2] during the season of 1936 indicates a fairly large usage of fertilizers for cotton. Furthermore, inquiries from farmers and agricultural workers show that there is considerable interest in analyses and rates of application of fertilizers best suited for cotton.

During the past ten years, the Experiment Station has conducted a series of fertilizer tests on cotton. In addition, tests have been conducted cooperatively with quite a number of farmers in the state and at each of the branch experiment stations. The results of the tests carried on each year have been given in the annual preliminary reports of the Department of Crops and Soils. A summary of the results of all the tests conducted on the coastal plain soils of Louisiana is reported herein.

PLAN OF EXPERIMENTS

These fertilizer experiments were designed to determine the ratio or analyses of fertilizers best suited for the production of cotton and to give some information as to the amounts per acre which may be profitably used.

The tests were based upon a 5-8-4 analysis. These figures signify a composition of the fertilizer as follows: 5.0 per cent nitrogen (N); 8.0 per cent phosphoric acid (P_2O_5); and 4.0 per cent potash (K_2O). Within this basic analysis, each of the fertilizing constituents was varied, one at a time. Thus, as shown in Table 1, the fertilizer applied to plats Nos. 1 to 5 contained 5 per cent nitrogen and 4 per cent of potash but varying amounts of phosphoric acid. Similarly, plats Nos. 7 to 12 received varying amounts of nitrogen with the phosphoric acid and potash constant, and plats Nos. 14 to 18 represented the potash series. Plats Nos. 6 and 13 were not fertilized.

The fertilizer was applied at a rate equivalent to 600 pounds per acre. The cotton was grown continuously on the same land in most instances, and the plats were located in the same places each successive year. No intervening crops were grown for the duration of the experiments.

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[1] Agricultural Statistics, 1936. Prepared by the Yearbook Statistical Committee of the U. S. Department of Agriculture.

[2] Figures from the Department of Agriculture and Immigration, State of Louisiana.

Each plat consisted of two rows of sufficient length to provide one-fiftieth of an acre. The plats were separated from each other by an unfertilized border row. Each treatment was replicated four times in each test, the replications being arranged in a manner to minimize, as far as possible, the effects of any variations in the soil. The fertilizer was distributed in the furrow and "bedded on" about two weeks before planting. The cotton was "chopped out" and cultivated according to the usual farm practices. In most instances, the cotton was picked twice, an attempt being made to get one-half of the crop at the first picking and the remainder at the second picking.

Description of Soils

The upland or hill soils on which these tests have been conducted are relatively similar in fertility although they represent a number of different soil types. At the North Louisiana Experiment Station at Calhoun the test was conducted on Orangeburg fine sandy loam; at both Homer and DeRidder it was located on Ruston fine sandy loam; and at Ruston, on Greenville fine sandy loam. These soil types represent the red hill lands of northern Louisiana. Considerable areas of them also occur in St. Helena and Washington parishes and in the northern half of Tangipahoa parish. These soils occur on rolling to hilly areas and are grayish-brown to reddish-brown in color. They have friable, well-drained subsoils ranging from red to yellow in color. The subsoil of the Greenville series is somewhat heavier in texture than that of either of the others.

The Bowie fine sandy loam, on which the test was located at Grand Cane, is also a hill soil but it has a less permeable subsoil than the above-mentioned soils. It is representative of the area extending from DeSoto through Vernon parish along the western side of the state.

At Hammond the test was located on Caddo very fine sandy loam. This is in the so-called "Flatwoods" or Gulf Coastal area which occupies the eastern part of Livingston, the southern half of Tangipahoa, and practically all of St. Tammany parish.

At Gurley, the test was conducted on Granada silt loam. The Granada is not strictly a Coastal Plain soil. It is one of the river bluff or hill soils of which the parent material is considered as being of loessial or wind-blown origin. These soils occupy the hills east of the Mississippi River and occur in Louisiana in East Baton Rouge and East and West Feliciana parishes. This area is bordered on the east by the Coastal Plain proper and the results of this test are included here because of their similarity to those of the Coastal Plains soils.

The results of two tests conducted on bottom or terrace soils of upland streams are also included in this report. At Franklinton, the test was located on a terrace or second bottom soil of the Bogue Chito River. The soil type was a Kalmia very fine sandy loam. It is composed entirely of the material outwashed from the adjoining coastal plain uplands which the river drains. The soil type represented at Monroe was the Ochlockonee very fine sandy loam occurring on a fairly high bottom of the Ouachita River. This is an alluvial soil composed of the outwash materials of the upland coastal plain mixed with those from the adjoining bottomlands and terraces east of the Ouachita River. In this respect this soil is not strictly an upland valley soil and differs somewhat from the Kalmia soil in fertility requirements.

The locations of the tests and the area of the state in which the results are applicable are shown in the map on the cover.

RESULTS ON UPLAND SOILS

The average annual yields of seed cotton produced by the different fertilizer ratios at each of the tests are given in Table 1. Figures on the annual net profit resulting from the use of fertilizers have been calculated and are given in Table 2.

As shown in Table 1, the use of phosphate when nitrogen and potash were supplied gave increased yields of cotton in every case (plats Nos. 1 to 6). The largest increase in yield was obtained from the largest application of phosphate, i. e., 96 pounds of phosphoric acid per acre, at all of the tests except two; 48 pounds of phosphoric acid per acre gave the largest yield at DeRidder and 72 pounds per acre at Gurley. The increase in yield from the use of phosphate under these circumstances ranged from 148 pounds of seed cotton per acre at Callhoun to 471 pounds at Gurley, with an average for all tests of 258 pounds. In the figures in Table 2 the cost of the fertilizer has been subtracted from the value of the increased yield of seed cotton. These figures show that 24 pounds of phosphoric acid per acre was the most profitable application at four of the locations: Calhoun, Homer, Ruston, and Grand Cane. The application of 48 pounds per acre was the most profitable at DeRidder, and ranked second at Hammond and Gurley. The average of all tests shows that the application of 48 pounds per acre of phosphoric acid along with 30 pounds nitrogen and 24 pounds potash gave a net profit per acre of $12.86, and that 24 pounds per acre of phosphoric acid gave $12.38 per acre. These figures represent returns of $3.49 and $5.58, respectively, per dollar invested for phosphate. The lower rate of application gave the larger return *per dollar invested.*

As shown in Table 1, plats Nos. 7 to 12, the largest yield of seed cotton in five of the tests was produced by 42 pounds of nitrogen per acre. Thirty pounds of nitrogen per acre gave the maximum yield at Homer and 36 pounds at Hammond. The largest net profit per acre, as indicated in Table 2, was obtained from the largest yield per acre at all tests, with the exception of the one at Hammond where the largest profit was produced by 24 pounds of nitrogen per acre. As an average of all tests, 30 pounds of nitrogen per acre gave the largest profits, returning $12.62 per acre above the cost of the fertilizer. The 24-pound rate gave a profit of $12.26 per acre and 36 pounds of nitrogen gave $12.25 profit per acre. It should be noted than 24 pounds of nitrogen per acre gave close to the maximum profits obtained from the use of nitrogen at all tests, with the exception of the one at Gurley.

The response to potash, as shown by plats Nos. 14 to 18, varied somewhat with the different soils. The increase in yield resulting from the inclusion of potash in the fertilizer ranged from 23 to 652 pounds of seed cotton per acre, with an average for all tests of 235 pounds per acre. Thirty-six and 48 pounds of potash per acre gave the largest returns above the cost of the potash. However, the profits from 24 pounds of potash per acre are very close to those obtained from the larger application.

Expressed in terms of total profit per acre, the most profitable rates of application of the plant food constituents in these tests have been, on the average, as follows: 30 pounds of nitrogen, 48 pounds of phosphoric acid, and 36 pounds of potash. This indicates that a 5-8-6 fertilizer applied at the rate of 600 pounds per acre gives the average maximum profit per acre for these soils. The 5-8-6 ratio is not registered in the state, but 500 pounds per acre of a 6-10-7 fertilizer would supply the required quantities of nitrogen, phosphoric acid, and potash. While there is little doubt that

Table 1. Plat Number, Fertilizer Treatment, and Average Annual Yields per acre of Seed Cotton Produced by the Different Fertilizer Analyses.

Plat No.	*Analysis of fertilizer applied at rate of 600 lbs. per acre**	*Calhoun 7-year average 1927-1933*	*Homer 5-year average 1929-1933*	*DeRidder 4-year average 1930-1934*	*Ruston 3-year average 1934-1936*	*Grand Cane 2-year average 1934-1935*	*Hammond 1 year 1929*	*Gurley 5-year average 1932-1936*	*Average of all tests— 27 years*
1	5-0-4	1088	811	984	551	589	1377	266	809
2	5-4-4	1186	977	1217	666	718	1448	626	977
3	5-8-4	1197	986	1316	689	708	1551	685	1019
4	5-12-4	1230	991	1251	680	713	1557	737	1023
5	5-16-4	1236	1064	1303	788	739	1614	726	1067
6	0-0-0	804	603	618	363	468	871	188	559
7	0-8-4	975	760	789	415	542	1045	459	712
8	3-8-4	1167	999	1112	659	595	1331	589	922
9	4-8-4	1232	1010	1214	660	640	1502	665	989
10	5-8-4	1267	1124	1243	726	615	1372	743	1013
11	6-8-4	1238	1048	1220	723	626	1527	749	1019
12	7-8-4	1302	1095	1288	773	691	1239	795	1026
13	0-0-0	725	559	574	359	412	816	219	523
14	5-8-0	1119	1042	879	754	647	753	605	828
15	5-8-2	1171	1056	1114	725	655	1347	696	966
16	5-8-4	1188	1065	1235	777	665	1370	716	1002
17	5-8-6	1220	1131	1245	728	678	1405	768	1025
18	5-8-8	1252	1116	1314	748	697	1375	741	1035

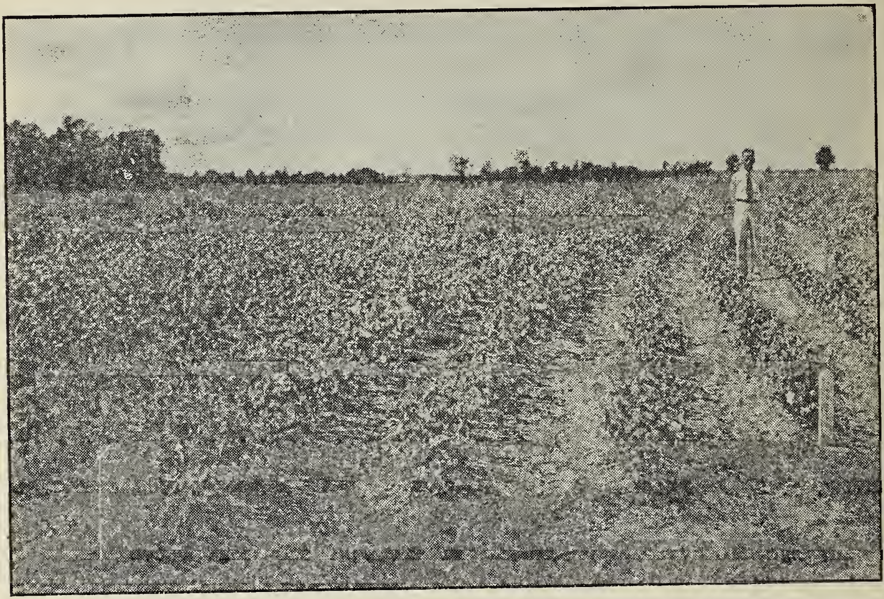
*Nitrate of soda was used as the source of nitrogen, superphosphate as the source of phosphoric acid, and muriate of potash as the source of potash.

Table 2. Plat Number, Fertilizer Treatment, and Average Annual Net Profit per acre from Different Fertilizer Analyses*

Plat No.	*Analysis of fertilizer applied at rate of 600 lbs. per acre*	*Calhoun 7-year average 1927-1933*	*Homer 5-year average 1929-1933*	*DeRidder 4-year average 1930-1934*	*Ruston 3-year average 1934-1936*	*Grand Cane 2-year average 1934-1935*	*Hammond 1 year 1929*	*Gurley 5-year average 1932-1936*	*Average of all tests—27 years*
1	5-0-4	$ 9.12	$ 5.36	$11.68	$ 3.76	$ 2.12	$17.48	$ -1.36	$ 6.88
2	5-4-4	11.84	10.80	19.80	7.16	6.08	19.12	11.84	12.38
3	5-8-4	11.08	9.96	22.56	6.88	4.48	22.04	13.00	12.86
4	5-12-4	11.20	8.96	18.76	5.32	3.48	21.08	13.88	11.81
5	5-16-4	10.24	10.68	19.64	8.44	3.32	22.16	12.24	12.39
6	0-0-0	——	——	——	——	——	——	——	——
7	0-8-4	5.20	3.92	4.48	-1.08	.84	4.80	6.96	3.59
8	3-8-4	11.08	11.68	15.60	6.88	1.16	14.44	10.36	10.17
9	4-8-4	13.08	11.52	19.08	6.32	2.36	20.68	12.80	12.26
10	5-8-4	13.88	15.48	19.64	8.36	.76	14.88	15.32	12.62
11	6-8-4	12.12	11.84	18.12	7.64	.60	20.48	14.96	12.25
12	7-8-4	14.08	13.12	20.24	9.04	2.60	8.36	16.20	11.95
13	0-0-0	——	——	——	——	——	——	——	——
14	5-8-0	8.80	13.04	5.92	10.32	2.88	-9.04	10.64	6.08
15	5-8-2	10.46	13.18	14.90	8.74	2.78	14.30	13.86	11.17
16	5-8-4	10.72	13.12	19.32	10.40	2.76	14.80	14.24	12.19
17	5-8-6	11.58	15.34	19.30	8.02	2.86	15.76	15.90	12.69
18	5-8-8	12.44	14.32	21.64	8.40	3.20	14.16	14.40	12.65

*The seed cotton was valued at 4c per pound, nitrate of soda at $32.00 per ton, 20% superphosphate at $20.00, and muriate of potash at $35.00.

FIGURE 1. SHOWING THE EFFECT OF ADEQUATE FERTILIZATION UPON THE APPEARANCE AND YIELD OF COTTON AT RUSTON, LOUISIANA. 1934.



Treatment Rows 1 and 2
600 lbs. of 5-16-4
fertilizer per acre

Yield

814 pounds of seed
cotton per acre

Treatment Rows 3 and 4
Not fertilized

Yield

450 pounds of seed
cotton per acre

an application of 500 pounds per acre of a 6-10-7 fertilizer would give the largest profits per acre on many soils, it is not considered as the best *general* recommendation for the soils of this area. It has been pointed out that the 24-pound-per-acre applications of each of the plant food constituents—nitrogen, phosphoric acid, and potash—gave very close to the maximum profits in their respective series. A fertilizer application supplying them in these quantities should give very good results. Consequently, 300 pounds per acre of an 8-8-8 fertilizer is *recommended for cotton in this area.* This amount of potash is not necessary on the soils having the heavier subsoil such as the Greenville and Bowie. An 8-8-4 or 8-8-6 ratio would be better adapted to them. These ratios are not yet registered but it appears that there is a need for the 8-8-4 ratio.

On the flatwoods and loessial bluff soils of the Florida parishes, larger quantities of phosphoric acid are needed to produce the maximum yield of cotton. A better recommendation for cotton in this area is 400 pounds per acre of a 6-10-7 fertilizer.

RESULTS ON THE UPLAND VALLEY SOILS

The average annual yields and net profits per acre produced by the different fertilizer analyses in the tests on the Upland Valley or bottom soils are given in Table 3.

Table 3. Plat Number, Fertilizer Treatment, and Average Annual Yield and Net Profit per acre from Different Fertilizer Analyses.*

Plat No.	Analysis of fertilizer applied at rate of 600 lbs. per acre	*Yield—Pounds of seed cotton per acre*			*Profit per acre***		
		Monroe 5-year average 1927-1931	*Franklinton 2-year average 1935-1936*	*Average of two tests—7 year's results*	*Monroe 5-year average 1927-1931*	*Franklinton 2-year average 1935-1936*	*Average of two tests—7 years' results*
1	5-0-4	1575	1027	1301	$16.16	$19.20	$17.68
2	5-4-4	1573	1245	1409	14.88	26.72	20.80
3	5-8-4	1553	1255	1404	12.88	25.92	19.40
4	5-12-4	1537	1286	1412	11.04	25.96	18.50
5	5-16-4	1622	1251	1436	13.24	23.36	18.30
6	0-0-0	1115	451	784	——	——	——
7	0-8-4	1313	790	1052	6.28	10.32	8.30
8	3-8-4	1549	1034	1292	13.92	18.28	16.10
9	4-8-4	1594	1110	1352	15.12	20.72	17.92
10	5-8-4	1675	1170	1423	17.76	22.52	20.14
11	6-8-4	1687	1214	1450	17.64	23.68	20.66
12	7-8-4	1706	1257	1482	17.80	24.80	21.30
13	0-0-0	1035	450	742	——	——	——
14	5-8-0	1395	845	1120	7.40	10.36	8.88
15	5-8-2	1490	1013	1251	10.78	16.66	13.72
16	5-8-4	1565	1177	1371	13.36	22.80	18.08
17	5-8-6	1590	1255	1422	13.94	25.50	19.72
18	5-8-8	1674	1277	1475	16.88	25.96	21.42

*Nitrate of soda was used as the source of nitrogen, superphosphate as the source of phosphoric acid, and muriate of potash as the source of potash.

**The seed cotton was valued at 4c per pound, nitrate of soda $32.00 per ton, 20% superphosphate at $20.00, and muriate of potash at $35.00.

The response in yield of cotton and the profits obtained from applications of nitrogen and potash on the two soils are quite similar. In regard to phosphoric acid, however, they differ. A quite profitable increase in yield was obtained from the use of 24 pounds of phosphoric acid per acre at Franklinton, while no response at all was obtained at Monroe. These tests definitely indicate the fertilizer needs of the soils on which they were conducted, but are inadequate in number to provide a good general idea of the fertilizer needs of the upland valley soils. From the information at hand and from knowledge of fertilizing practices, it would be expected that the use of 300 to 400 pounds of an 8-8-8 fertilizer would be quite profitable on the sandier stream bottom soils. The absence of response to phosphate fertilization on the soil at Monroe is not considered as normal nor representative of stream bottom soils.

SUMMARY

The results of cooperative cotton fertilizer tests conducted on the Coastal Plain soils of northern Louisiana from 1927 to 1936, inclusive, are reported.

The locations at which the tests were conducted and the area in which the results are applicable are shown on an outline map of the state.

The use of 300 pounds per acre of an 8-8-8 fertilizer for the production of cotton on the hill and upland valley soils of the interior coastal plain is recommended.

The use of 400 pounds per acre of a 6-10-7 fertilizer for the production of cotton on the loessial bluffs and flatwoods soils east of the river is recommended.

Wide fluctuations or changes in the price of cotton or the cost of fertilizer materials would materially affect the value of the figures on profit on which these recommendations are based.

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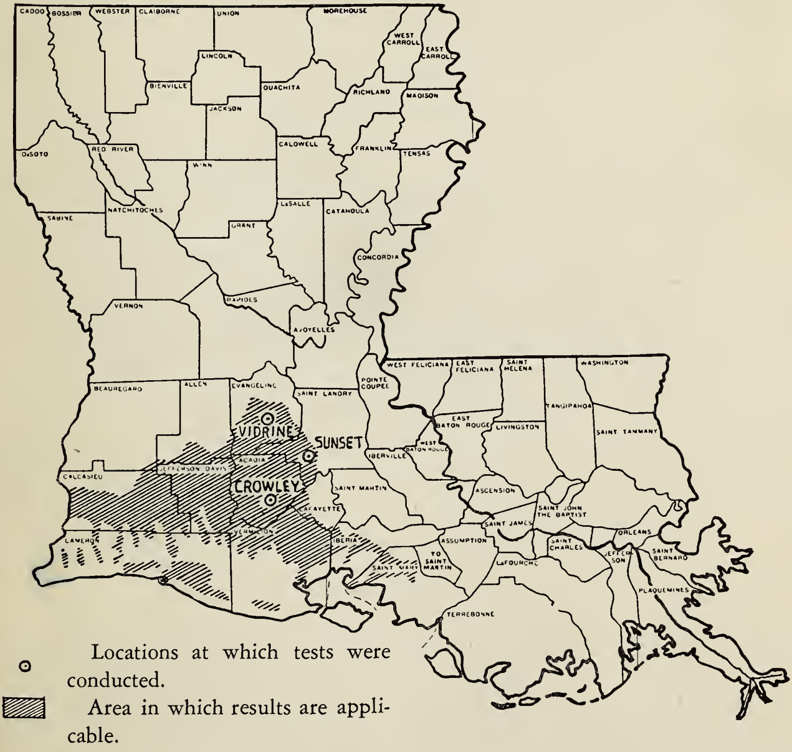
Louisiana Bulletin No. 286 April, 1937

Fertilizers for Cotton on the Prairie Soils of Southwest Louisiana

By
H. C. LOVETT
AND
FRANKLIN L. DAVIS



⊙ Locations at which tests were conducted.

▨ Area in which results are applicable.

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

STATEMENT

The test at Crowley has been conducted cooperatively by J. Mitchell Jenkins, Superintendent of the Rice Experiment Station. The Outfield tests have been conducted on the farms of Frank Dimick at Sunset and Aurelis Mayeux at Vidrine in cooperation with the County Agricultural Agents of the respective parishes. Members of the Department of Crops and Soils who have supervised or conducted the experiments have been H. B. Brown, John Gray, the late A. H. Meyer, John R. Cotton, H. C. Lovett, and Franklin L. Davis. The manuscript has been prepared by H. C. Lovett and Franklin L. Davis.

Fertilizers for Cotton on the Prairie Soils of Southwest Louisiana

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AND

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In a discussion of any soil-improving practice, such as the use of fertilizers, there is but one sound basis upon which the value of the practices can be measured, and that is profit. This is well demonstrated by the fact that only those practices that have proven profitable to the farmer have persisted and have wide-spread application. Even when the expressed purpose for soil-improvement measures is "to maintain soil fertility" or "to conserve the soil," the fundamental reason for following them is that they will eventually produce profitable returns.

The average yield of cotton in Louisiana is approximately 200 pounds per acre of lint cotton.[1] There is no doubt but that these yields can be profitably increased. This can be done by following soil-improving and conserving practices such as rotating the crops grown, turning under certain green legumes, and applying the right kinds and amounts of commercial fertilizers.

While not all of the fertilizer used in the state is applied to cotton, a consumption of nearly 106,000 tons[2] during the season of 1936 indicates a fairly large usage of fertilizers for cotton. Furthermore, inquiries from farmers and agricultural workers show that there is considerable interest in analyses and rates of application of fertilizers best suited for cotton.

During the past ten years, the Experiment Station has conducted a series of fertilizer tests on cotton. In addition, tests have been conducted cooperatively with quite a number of farmers in the state and at each of the branch experiment stations. The results of the tests carried on each year have been given in the annual preliminary reports of the Department of Crops and Soils. A summary of the results of all tests conducted on the pariric soils of southwestern Louisiana is reported herein.

PLAN OF EXPERIMENTS

The fertilizer experiments were designed to determine the ratio or analyses of fertilizers best suited for the production of cotton. They also give some information as to the amounts per acre that may be profitably used.

The tests were based upon a 5-8-4 analysis. These figures signify a composition of the fertilizer as follows: 5.0 per cent nitrogen (N), 8.0 per cent phosphoric acid (P_2O_5), and 4.0 per cent potash (K_2O). Within this basic analysis each of the fertilizing constituents was varied, one at a time. Thus as shown in Table 1, the fertilizer applied to plats Nos. 1 to 5 contained 5 per cent of nitrogen and 4 per cent of potash but different amounts of phosphoric acid. Similarly, plats Nos. 7 to 12 received varying amounts of nitrogen with the phosphoric acid and potash constant, and plats Nos. 14 to 18 represented the potash series. Plats Nos. 6 and 13 were not fertilized.

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[1] Agricultural Statistics, 1936. Prepared by the Yearbook Statistical Committee of the U. S. Department of Agriculture.

[2] Figures from the Department of Agriculture and Immigration, State of Louisiana.

The fertilizer was applied at a rate equivalent to 600 pounds per acre. The cotton was grown continuously on the same land in most instances, and the plats were located in the same places each successive year. No intervening crops were grown for the duration of the experiments.

Each plat consisted of two rows of sufficient length to provide one-fiftieth of an acre. The plats were separated from each other by an unfertilized border row. Each treatment was replicated four times in each test, the replications being arranged in a manner to minimize, as far as possible, the effects of any variations in the soil.

The fertilizer was distributed in the furrow and "bedded on" about two weeks before planting. The cotton was "chopped out" and cultivated according to the usual farm practices. In most instances, the cotton was picked two times, an attempt being made to get one-half of the crop at the first picking and the remainder at the second picking.

Description of Soils

The tests have been conducted at three places, a different soil type being represented at each of the places. The locations of the tests and the area of the state in which the results are applicable are shown in the map on the cover.

At the Rice Experiment Station at Crowley, the test was conducted on Crowley silty clay loam soil and at Vidrine, on Crowley silt loam. Crowley silty clay loam is the typical rice land of southwestern Louisiana. Crowley silt loam is lighter in texture and contains considerably less clay in both the surface and sub-soil. The surfaces of these soils are light brown to brownish-gray in color, changing to a distinct ashy-gray color when they become dry. Both occur extensively throughout the area.

At Sunset, the test was located on the prairie phase of the Olivier silt loam. Olivier silt loam is primarily a terrace soil and occurs extensively on Washington Ridge, which forms the eastern boundary of the prairie proper. It is also found locally on the more rolling areas of the eastern part of the prairie. It is similar to the Crowley series in color and the prairie phase seems to be quite similar to the Crowley soils in response to fertilizers.

Discussion of Results

The average annual yields of seed cotton produced by the different fertilizer ratios at each of the tests are shown in Table 1. Figures on the annual net profit resulting from the use of fertilizers have been calculated and are given in Table 2.

As shown in Table 1, increased yields of cotton were obtained in every case from the use of phosphate. The increases, as shown by a comparison of the yields on plats Nos. 1 to 5, amounted to 297 pounds per acre of seed cotton at Sunset, 351 pounds at Vidrine, and 406 pounds at Crowley. The largest increase in yield was produced by the maximum application of phosphate at both Crowley and Vidrine. At Sunset, the 8 per cent phosphoric acid, or 48 pounds per acre, gave the largest yield. The data in Table 2 show that 48 pounds per acre of phosphoric acid produced the largest net profit in every case. This profit has amounted to $12.08, $9.44, and $9.48 per acre at Crowley, Vidrine, and Sunset, respectively. Expressed in another way, these profits represent an average return of $4.30 per $1.00 invested for phosphate on these soils.

The response to gradually increasing applications of nitrogen is shown in particular by the yields of plats Nos. 7 to 12, inclusive. Supplying nitrogen has resulted in

TABLE 1. PLAT NUMBERS, FERTILIZER TREATMENT, AND AVERAGE ANNUAL YIELDS PER ACRE OF SEED COTTON PRODUCED BY THE DIFFERENT FERTILIZER ANALYSES.

Plat No.	*Analysis of fertilizer applied at the rate of 600 pounds per acre**	*Crowley 8-year average 1928-36*	*Vidrine 3-year average 1934-36*	*Sunset 3-year average 1930-31, 1935*	*Average of all tests 14 years*
		pounds	*pounds*	*pounds*	*pounds*
1	5-0-4	543	948	799	763
2	5-4-4	864	1172	1012	1016
3	5-8-4	905	1244	1096	1082
4	5-12-4	922	1269	1002	1064
5	5-16-4	949	1299	1033	1094
6	0-0-0	388	782	578	583
7	0-8-4	656	1071	854	860
8	3-8-4	809	1256	986	1017
9	4-8-4	859	1267	1079	1068
10	5-8-4	934	1299	1071	1101
11	6-8-4	931	1266	978	1058
12	7-8-4	991	1271	965	1076
13	0-0-0	369	781	514	555
14	5-8-0	653	1037	729	806
15	5-8-2	834	1188	871	964
16	5-8-4	919	1228	989	1045
17	5-8-6	944	1266	1089	1100
18	5-8-8	975	1277	1226	1159

*Nitrate of soda was used as the source of nitrogen, superphosphate as the source of phosphoric acid, and muriate of potash as the source of potash.

substantial increases in yields, but the increases are not as large as those produced by applications of phosphate. The maximum net profit, as well as the largest increase in yield, from the use of nitrogen on these soils was obtained from the mixture containing 7 per cent nitrogen at Crowley, 5 per cent at Vidrine, and 4 per cent at Sunset. In all probability this variation in the response to nitrogen is largely due to previous cultural practices, particularly as they affected the amount of organic matter in the soils. It should be noted in Table 2 that 5 per cent nitrogen in the fertilizer gave close to the largest net profits at Crowley and that there was little difference between the net profits obained from 4 and 5 per cent nitrogen at both Vidrine and Sunset. The average of all the tests shows that the largest annual net profit, $6.64 per acre, was obtained from 5 per cent nitrogen, with 4 per cent nitrogen a close second at $5.92 per acre. These profits represent returns of $2.21 and $2.37, respectively, per $1.00 invested for nitrogen fertilizers.

Inclusion of potash in the fertilizer gave increased yields of seed cotton in every case. The largest increase in yield in each test was produced by the maximum application of potash. These annual increases amounted to 322 pounds per acre of seed cotton at Crowley, 240 pounds at Vidrine, and 479 pounds at Sunset. As an average, they are higher than those obtained from the application of phosphate. The largest net profits from the use of potash were produced by applications of 48 pounds per acre. At Crowley these profits exceeded those obtained from 6 per cent

TABLE 2. PLAT NUMBER, FERTILIZER TREATMENT, AND AVERAGE ANNUAL NET PROFIT PER ACRE FROM DIFFERENT FERTILIZER ANALYSES.*

Plat No.	*Analysis of fertilizer applied at the rate of 600 pounds per acre*	*Crowley 8-year average 1928-36*	*Vidrine 3-year average 1934-36*	*Sunset 3-year average 1930-31, 1935*	*Average of all tests 14 years*
1	5-0-4	$ 2.72	$ 2.80	$ 6.28	$ 3.93
2	5-4-4	14.36	10.56	13.60	12.84
3	5-8-4	14.80	12.24	15.76	14.27
4	5-12-4	14.28	12.04	10.80	12.37
5	5-16-4	14.16	12.04	10.84	12.35
6	0-0-0	——	——	——	——
7	0-8-4	7.84	8.32	9.08	8.41
8	3-8-4	12.16	13.92	12.56	12.88
9	4-8-4	13.56	13.76	15.68	14.33
10	5-8-4	15.96	14.44	14.76	15.05
11	6-8-4	15.24	12.52	10.44	12.73
12	7-8-4	17.04	12.12	9.32	12.83
13	0-0-0	——	——	——	——
14	5-8-0	5.56	4.80	1.92	4.09
15	5-8-2	12.38	10.42	7.18	9.99
16	5-8-4	15.36	11.60	11.48	12.81
17	5-8-6	15.94	12.70	15.06	14.57
18	5-8-8	16.76	12.72	20.12	16.53

*The seed cotton was valued at 4c per pound, nitrate of soda at $32.00 per ton, 20% superphosphate at $20.00, and muriate of potash at $35.00.

potash in the mixture by 80 cents per acre, and at Vidrine, by only 2 cents per acre. An average increase in net profits of $12.44 per acre resulted from applications of 48 pounds of potash per acre at the three tests. This represents an average annual return of $6.80 per $1.00 invested in potash.

Cotton rust is more prevalent on the prairie soils than on other soils of the State. Damage to the cotton crop by cotton rust and the consequent reduction of yield is largely prevented by the use of fertilizers containing sufficient quantities of potash. The effect of adequate fertilization upon the appearance of cotton at picking time is shown in Figure 1. This photograph shows adjoining plats in a rate of application of potash test conducted at Lacassine from 1931 through 1936* In this test an annual application of 600 pounds per acre of a 5-12-8 fertilizer has given a five-year average yield of 1454 pounds of seed cotton per acre, as compared to 1581 pounds from the 5-12-12. The unfertilized plats yielded an average of 660 pounded per acre of seed cotton annually and the 5-12-0 mixture, 835 pounds.

The results secured in these experiments show that relatively large amounts of potash should be used for the production of cotton on these soils. In two of the tests, 48 pounds of potash, or 8 per cent K_2O in a mixture applied at the rate of 600 pounds per acre, gave the largest returns, with the 6 per cent K_2O mixtures closely approaching them in profits. The data at Sunset indicate that even larger quantities might be profitable, and at Lacassine, increased yields and profits were obtained from 12 per cent potash. Eight per cent phosphoric acid was the most profitable in each of the tests. The percentages of nitrogen giving the largest net returns were somewhat variable, but showed, on the average, that 5 per cent was most profitable. As an average of the tests, the 5-8-8 analysis is indicated as being the most profitable. This fertilizer ratio is not registered in the state. The commercial mixtures most nearly approaching this ratio are the 4-8-6 and the 4-8-10 analyses. Very good results can be expected on these soils from applications of as much as 600 pounds per acre of a 4-8-6 fertilizer. In those areas in which cotton is excessively damaged by cotton rust, the 4-8-10 mixture should be used.

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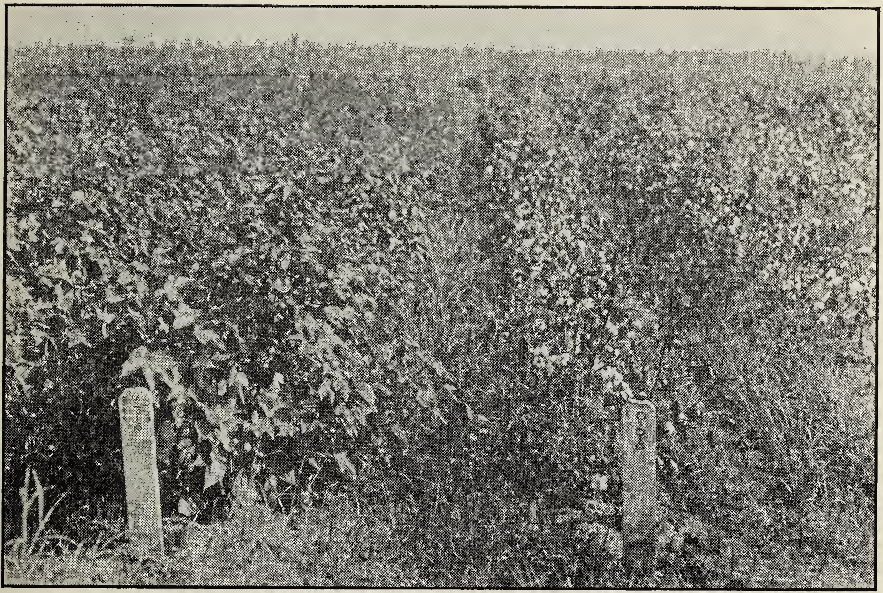
*Preliminary Report of the Department of Crops and Soils, Louisiana Experiment Station, 1936.

FIGURE 1. SHOWING THE EFFECTS OF ADEQUATE FERTILIZATION UPON THE APPEARANCE AND YIELD OF COTTON AT LACASSINE, LOUISIANA. 1934.



Treatment 600 pounds of a 5-12-12 fertilizer per acre	Treatment Not fertilized
Yield 2119 pounds per acre of seed cotton	Yield 700 pounds per acre of seed cotton

SUMMARY

The results of cooperative cotton fertilizer tests conducted on the prairie soils of southwest Louisiana from 1928 to 1936, inclusive, are reported.

Applications of 600 pounds per acre of a 5-8-8 analysis produced net profits ranging from $12.72 to $20.12 per acre, with an average of $16.53. These profits represent an average return of $3.33 per $1.00 invested in the fertilizer.

When added to combinations of the other two fertilizing constituents, potash gave larger increases in yields and greater net profits per dollar invested than did either phosphoric acid or nitrogen.

The area of the state to which the results of these tests are applicable is shown on a parish outline map of the state.

Recommendations are made for the fertilization of cotton in this area.

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LOUISIANA BULLETIN NO. 287 MAY, 1937

Eight-Year Summary of Horticultural Investigations

By

JULIAN C. MILLER
and
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LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. DOWELL, *Director*

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1937

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Eight-Year Summary of Horticultural Investigations

INTRODUCTION

This is a summary of results obtained by the Horticulture Department of the Louisiana Agricultural Experiment Station from 1929 through 1936. For many of the subjects discussed more complete information may be had from reading the publications which are listed. A number of projects are being continued and results will be published when warranted by sufficient data.

The crops worked with are listed alphabetically and the type of work done may be classed as cultural, breeding, or physiological. In general, the truck crops most important to the State have been given the most attention.

ASPARAGUS

While asparagus is not an important truck crop in Louisiana, an occasional attempt is made to grow it on a commercial scale even in the southern part of the State. At first the plants grow remarkably well and give promise of being very productive, but none of the projects has been successful.

An experiment was conducted at the Louisiana Agricultural Experiment Station to determine whether asparagus could be grown profitably in south Louisiana. The Mary Washington variety was used in this experiment. Some plots were cut in the fall, some in the spring, and some were cut partly in the fall and partly in the spring. Cutting was started on these plots when the plants had had two growing seasons after the crowns were set out. Data that illustrate the type of results obtained in this experiment are given in Tables 1 and 2. These data show that very low yields were obtained in the fall and that partial cutting in the fall greatly reduced the spring crop from those plants. Spring yields were much higher than fall yields but were very low in comparison with yields in good commercial asparagus sections. The yield behaviors are explained on the basis of food reserves, largely non-reducing sugars, in the crowns. In the fall very little food reserves were present and these were rapidly depleted; more were present in the spring but not enough to produce high yields. Under the conditions of this experiment, new growths of shoots were produced at approximately monthly intervals. With each burst of growth the food reserves were depleted. Thus, during the growing season very little food was stored in the crowns even though the plants made excellent growth. Apparently the reason that asparagus is not productive in the far South is that there is a lack of reserve food, rather than that the dormant season is too short. Another hazard of asparagus production in the far South is that during warm winters, shoots may start out in January. Asparagus is not recommended for commercial planting in south Louisiana.

Large crowns may be grown from seed in one year in this section. Many seedling plants produce flowers the first season and so pistillate and staminate plants may be separated.

CABBAGE

A new strain of cabbage which has been named LOUISIANA COPENHAGEN has been developed at the Louisiana Agricultural Experiment Station. It is the product of five generations of inbreeding and selection. It has been bred to meet climatic conditions and market requirements in Louisiana. Fig. 1 shows the interior

TABLE 1. YIELDS OF ASPARAGUS IN POUNDS PER ACRE IN TIME OF CUTTING TEST.

Treatment	*No. 1s*			*No. 2s*			*No. 3s*		
	*1932**	*1933*	*1934*	*1932*	*1933*	*1934*	*1932*	*1933*	*1934*
Cut in Fall (6 weeks)									
1st 3 weeks	25.4	34.4	9.3	73.8	50.5	6.7	22.8	61.5	38.0
2nd 3 weeks	0.0	0.4	2.6	3.8	2.8	2.2	10.9	35.6	10.6
TOTAL	25.4	34.8	11.9	77.6	53.3	8.9	33.7	97.1	48.6
Cut ½ Fall—½ Spring									
3 weeks in Fall	25.3	27.3	8.0	62.5	44.9	5.4	25.1	62.4	31.8
½ Spring season	32.4	7.9	3.7	30.2	14.7	15.6	17.9	33.5	26.0
TOTAL	57.7	35.2	11.7	92.7	59.6	21.0	43.0	95.9	57.8
Cut in Spring									
1st half of season	111.5	45.2	34.1	43.2	28.7	40.1	17.7	23.4	38.6
2nd half of season	156.3	105.1	20.7	88.0	89.1	28.8	22.8	59.7	34.8
TOTAL	267.8	150.3	54.8	131.2	117.8	68.9	40.5	83.1	73.4

*Spring harvest is following year in each case.

TABLE 2. ANALYSIS OF CROWNS IN THE TIME OF CUTTING TEST.*

Treatment	*Date of Sampling*	*Moisture, Per cent*	*Reducing Sugar, Per cent*	*Non-reducing Sugars, Per cent*	*Acid Hydrolyzable Material, Per cent*	*Insoluble N, Per cent*	*N, Per cent Soluble*
Cut in Spring	August 31, 1933	80.20	None	6.78	1.55	0.12	0.19
Cut in Fall	August 31, 1933	80.31	0.38	7.19	1.64	0.12	0.11
Cut in Spring	October 6, 1933	80.66	0.12	7.78	2.13	0.15	0.15
Cut ½ Fall— ½ Spring	October 6, 1933	84.22	0.52	4.93	1.95	0.12	0.17
Cut in Spring	October 27, 1933	78.33	Trace	8.36	2.03	0.14	0.14
Cut in Fall	October 27, 1933	84.45	0.43	4.48	1.80	0.11	0.15
Cut in Spring	January 19, 1934	79.46	Trace	7.54	2.05	0.23	0.29
Cut in Fall	January 19, 1934	81.90	0.42	5.45	1.92	0.11	0.16

*Results given are for 1933. Quite similar results were obtained in 1932 and 1934.

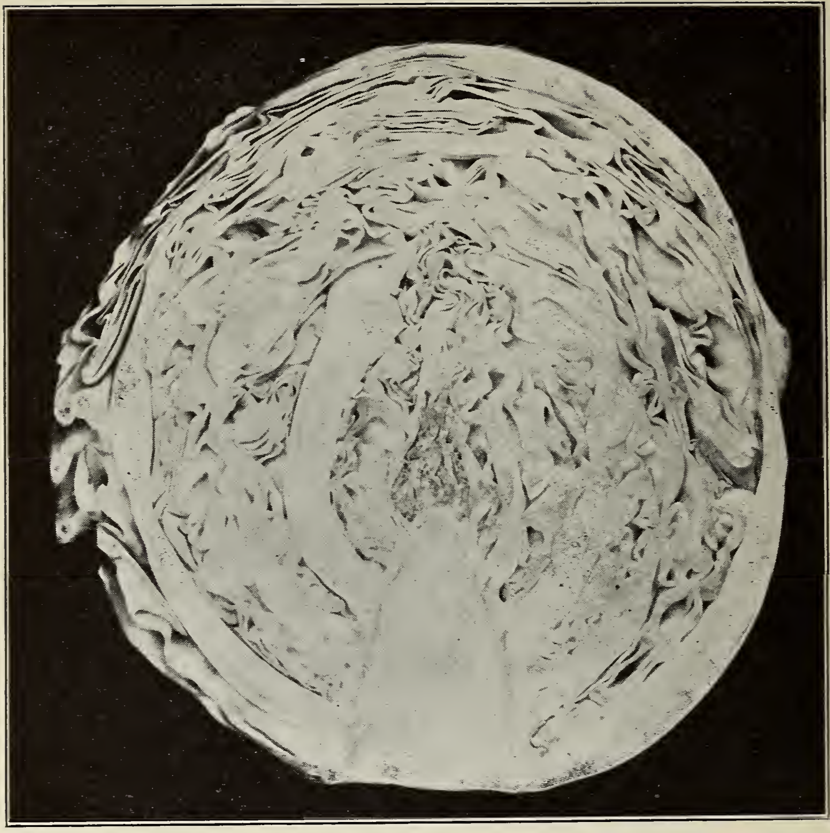

Figure 1. A detailed illustration of the compactness, size of core, and character of head leaf fold of Louisiana Copenhagen.

head characteristics of this cabbage. The plant is very uniform and resistant to premature seeding; the head is small to medium and very hard, the core is short, and the quality excellent. In 1936, 2000 pounds of seed of this cabbage were distributed by various agencies.

Table 3 shows the head measurements of the Louisiana Copenhagen as compared with those of the standard Copenhagen Market.

TABLE 3. COMPARISON OF HEAD MEASUREMENTS OF THE LOUISIANA COPENHAGEN WITH THOSE OF THE COPENHAGEN MARKET. AVERAGE MEASUREMENT OF 75 REPRESENTATIVE HEADS OF THE SPRING CROP—1934.

Strain	*Weight in Pounds*	*Width in Inches*	*Length in Inches*	*Length of Core in Inches*	*Ratio of Core Length to Head Length*
Louisiana Copenhagen..........	2.63	5.80	5.86	2.49	0 425
Copenhagen Market............	3.74	6.59	6.37	3.67	0.576

A breeding program similar to that conducted in the breeding of the Louisiana Copenhagen is now under way with the All-Head-Early. Crosses have also been made between the Charleston Wakefield and the Louisiana Copenhagen. The object of this cross is to breed a cold resistant, round-headed variety more suitable for midwinter than the Copenhagen type.

In all of the cabbage work, breeding for strains that are resistant to premature seeding has been kept in mind. Experiments have been conducted, and some are still in progress, to determine the cause and other factors associated with premature seeding. Some of these major factors are:

(1) The size of the plants and length of time of exposure to lower growing temperatures. In order for many of the plants to seed prematurely, the largest leaf of the plant must be about 2½ to 3 inches in width and 5 to 6 inches in length, and must be exposed to a low growing temperature of 35 to 55 degrees F. for a period of 30 to 60 days. The longer the exposure, the greater will be the percentage of seeders.

(2) The quality of the seed or the genetic constitution of the strain or variety. This factor has a marked influence on premature seeding. Cabbage is a cross-fertilized crop and crosses readily with other members of the cabbage family, such as kale, broccoli, and collards. These plants are annual seeders and do not require a rest period in many sections of the country as does cabbage. Therefore, when crosses occur between such plants and cabbage, the resulting plants require a very short rest period and develop seedstalks at a higher temperature than cabbage. By inbreeding some of these premature seeders found in cabbage fields, and planting this inbred seed, the resulting segregations show clearly that the seed is carrying a mixture of cabbage and kale. In many cases, definite segregations show kale. Kohl Rabi and broccoli have been found in plants resulting from these inbred seeders.

(3) The rigid selection of heads that have been grown under conditions favorable to premature seeding. In order to obtain a strain of cabbage resistant to premature seeding, rigid selection for ideal heads must be made from plantings that have been grown under conditions most favorable for premature seeding. In Louisiana this period is during December and January.

Two methods of handling the seed plants are used in Louisiana:

METHOD NO. 1. The outer leaves are removed from the selected plants. The plants are then placed in cold storage at 40 degrees F. and allowed to remain there for two months. They are then removed, potted in 8-inch pots, and placed in a greenhouse under growing conditions at 60 to 70 degrees F.

METHOD NO. 2. During November and December the plants are selected and the heads cut and examined for such characters as compactness, color, flavor, and the height and size of core. If the head is satisfactory, the stump is marked by placing a stake beside it. As soon as compact rosettes have developed, the stumps are transplanted to a seeding plot. Fig. 2 shows sprouts which have developed from the stump as described in Method No. 2.

Method No. 2 is much the better, as the plants produce a greater quantity of seed at less expense. However, plants do not seed during exceptionally warm winters and for this reason some heads are handled according to Method No. 1, primarily to insure an annual seed crop. For a complete description of these methods, see Louisiana Bulletin 260.

From fertilizer experiments conducted for the past five years it has been found that an application of 600 to 800 pounds of a 4-12-4 mixture per acre on a 3½-foot row basis was most economical. Two top dressings of nitrate of soda at the rate of

100 pounds per acre for each application should be applied during the growing period, one when the largest leaves are 2½ to 3 inches in width and another when leaves are about 5 inches in width.

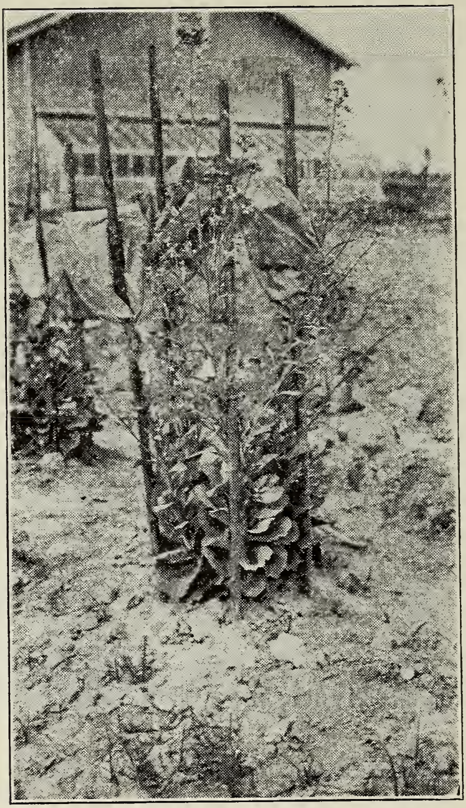

Figure 2. Sprouts developed from stump as described in Method No. 2.

CARROTS

During the past ten years, both California and Texas have ranked higher than Louisiana in the production of carrots. Studies showed that a large percentage of the Louisiana carrots were "off color" and that the buyers preferred the more uniformly colored carrots from the other two States. However, in examining various fields of carrots in Louisiana, some well-colored carrots were found in fields that had a high percentage of very poorly colored ones. Therefore, Danvers Half-Long and Imperator carrots are being grown under the most adverse conditions at the Experiment Station and then the very few well-colored roots are being selected for seed. At the present time both inbred and open-pollinated lines are being carried on. In order to maintain vigor, stocks are inbred for one season and allowed to open-pollinate in isolated plots the next season. This work has been conducted for five years and very satisfactory progress has been made. Seed of the best lot is now being increased in California for the Louisiana growers. Forty pounds of seed of this improved carrot, which will be known as the LOUISIANA DANVERS, was distributed to growers this past season and planted in comparison with commercial lots. Growers report very gratifying results from this improved seed. Arrangements for seed increase have been made with various organizations and it is estimated that 3000 pounds of Louisiana Danvers seed will be available in Louisiana next season.

A series of experiments has been conducted at the Louisiana Agricultural Experiment Station during the past seven years to study some of the factors that might affect color in carrots. It was found that all commercial varieties and strains were subject to off-color when planted during the fall and winter months. Various combinations of fertilizer, as well as the commonly-called minor elements, had no effect upon improving the color. The pH of the soil had no effect upon the color of carrots.

The soil type did have a marked influence upon color. In the plantings made on open or porous soils, either sandy or porous due to high organic content, better colored carrots were produced than on the heavier clay or silt soils. The plantings made upon high well-drained seedbeds also produced better color than those on low or flat beds. The late spring and early fall plantings produced better color than those made during the winter.

The factors which seem to be most closely associated with good color in carrots are soil aeration and the genetic constitution of the strain or variety. It appears that any condition, such as excess water or heavy soil, that causes packing about the roots and prevents sufficient soil aeration, has a tendency to induce off-color. There is a marked difference in the hereditary constitution of the different carrots. Even when carrots are grown in a water furrow to induce off-color, there can usually be found a number of well-colored roots. The well-colored roots can then be kept as breeding stock. It is this process of selecting that has been followed in breeding strains for good color.

CITRUS

Satsuma oranges are grown in certain sections of the State where injury due to freezes is often very severe. A planting of Satsuma trees was set out at the Louisiana Agricultural Experiment Station and various treatments were given to determine their effect on the winter hardiness of the trees. None of the treatments given prevented severe injury during periods of very low temperatures. Trees receiving heavy applications of nitrogen were more susceptible to cold injury than those receiving other treatments. Banking of the trees prevented injury to the part covered by soil, so banking is considered essential for Satsuma trees where severe winter injury is likely. Established banked trees recovered from freeze injury with marked rapidity. The plots receiving heavy applications of nitrogen made the most rapid growth.

Orchard heating is not practiced in the sweet orange section of Louisiana. Low temperatures are, however, often injurious at blooming time and are occasionally injurious to the trees during the winter. If heating could be established it might be advantageous. An attempt is being made to extend the orange section farther north, where the hazard of cold injury is greater, and means of orchard heating will likely be essential. A heating project has been carried on cooperatively for two seasons in a grove about ten miles south of New Orleans. Some very interesting results are being obtained. To date, injurious temperatures have occured only on clear, practically still nights. Under these conditions it has been found possible to raise the temperature in the heated area enough to protect the trees and fruit from injury.

COLLARDS

Although the collard has been grown in the South since the coming of the early English settlers, little systematic breeding has been done with this vegetable and there was great opportunity for improvement. Therefore, a program of inbreeding and selection has been followed with a marked degree of success. The problem has been to fix a definite, uniform type of plant that is free from purple or red color, having a deep compact rosette center and leaves with short petioles or stem. Last year, 1500 pounds of this improved seed were available to growers. This year 20 acres in Louisiana are planted to this strain for seed production.

The new strain of collards has been named LOUISIANA SWEET. Fig. 3 shows a typical plant and cross section of a plant of the Louisiana Sweet variety.

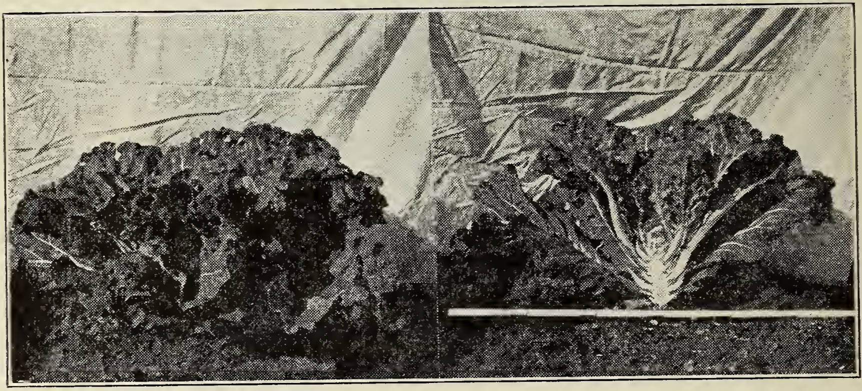

Figure 3. At the left is a typical plant of the Louisiana Sweet collards; at the right is a cross section of a plant of this variety.

The collard is the most important green vegetable found in southern gardens during the winter months. This is especially true in the cotton producing areas where the climate is less favorable for the production of fall and winter vegetable crops. The collard is also an important winter truck crop in Louisiana. Of the mixed vegetable cars shipped from Louisiana annually, it is estimated that 500 contain collards, or a volume equal to 150 cars of collards.

OKRA

Since Okra is one of Louisiana's most widely used vegetables, and since the varieties are not very well fixed, a project on okra breeding was set up at the Louisiana Agricultural Experiment Station. Work is being carried on with a number of inbred lines of the leading varieties, as well as a large number of crosses between different varieties possessing superior characters and a number of inbred selections that are spineless. Note the uniformity of pods of the LOUISIANA VELVET variety in Fig. 4 and that the diameter of these pods continues the same size to near the tip of the pod. Most of these pods are over 6 to 7 inches long and are still tender. Selection for the spineless character will continue until it has been fixed. The spineless strains are being crossed with other good strains not having this desirable

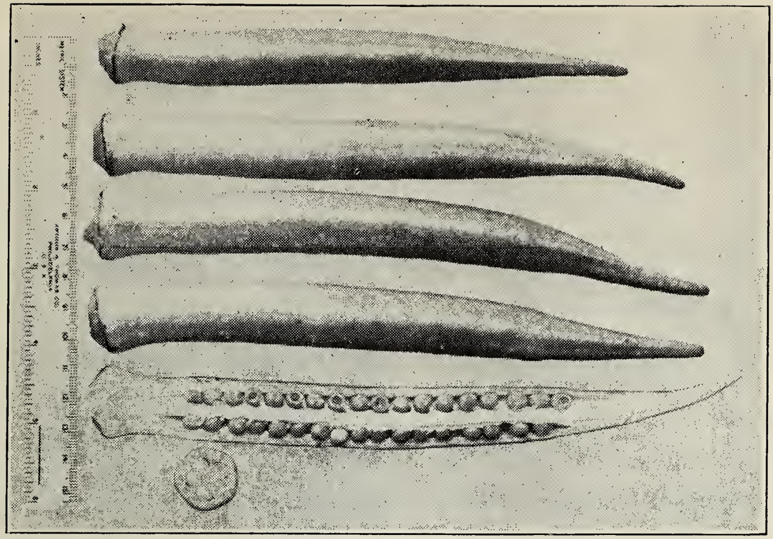

Figure 4. Several pods of the Louisiana Velvet, a strain which has been bred for the spineless character.

character, with the idea of combining as many of the better characters as possible into one strain.

Genetic studies, and particularly the mode of inheritance of some of the most pronounced characters, are being made with this crop.

ONIONS

The Creole onion is the best keeper, has more total solids, and is stronger than any other known variety. However, since no breeding work had been done with this onion, it was badly mixed as to definite characters. A breeding program is now under way at the Louisiana Agricultural Experiment Station to fix desired characters in this variety. Considerable progress has been made. Some of the better inbred lines are being increased for distribution.

The Shallot, a variety of green onion, is grown as a truck crop principally in Louisiana. A disease known as "pink root" causes considerable losses each year, especially in the older districts. To remedy this trouble, crosses were made between two of the best strains of shallots in an effort to segregate a new strain which would have enough vigor and resistance to produce a good crop on land heavily infected with pink root. Strains have been developed that are producing good crops on soils that are heavily infected with the pink root disease. Sets of these new strains will be distributed this year for increase and general planting.

PEAS, ENGLISH

The Creole pea is a native variety, probably brought here by the early French settlers. It is very vigorous and productive and also is resistant to cold, heat, mildew, and root rot. Its size and quality are not as good as some later introductions; therefore, crosses have been made between the Creole and some of the leading commercial varieties, such as Thomas Laxton, Laxtonian, and Telephone. Several promising selections have been made . To date, no seed is ready for distribution.

PEPPERS, HOT

Due to the importance of the pepper crop in Louisiana and to the very poor existing varieties, a breeding program was undertaken at the Louisiana Agricultural

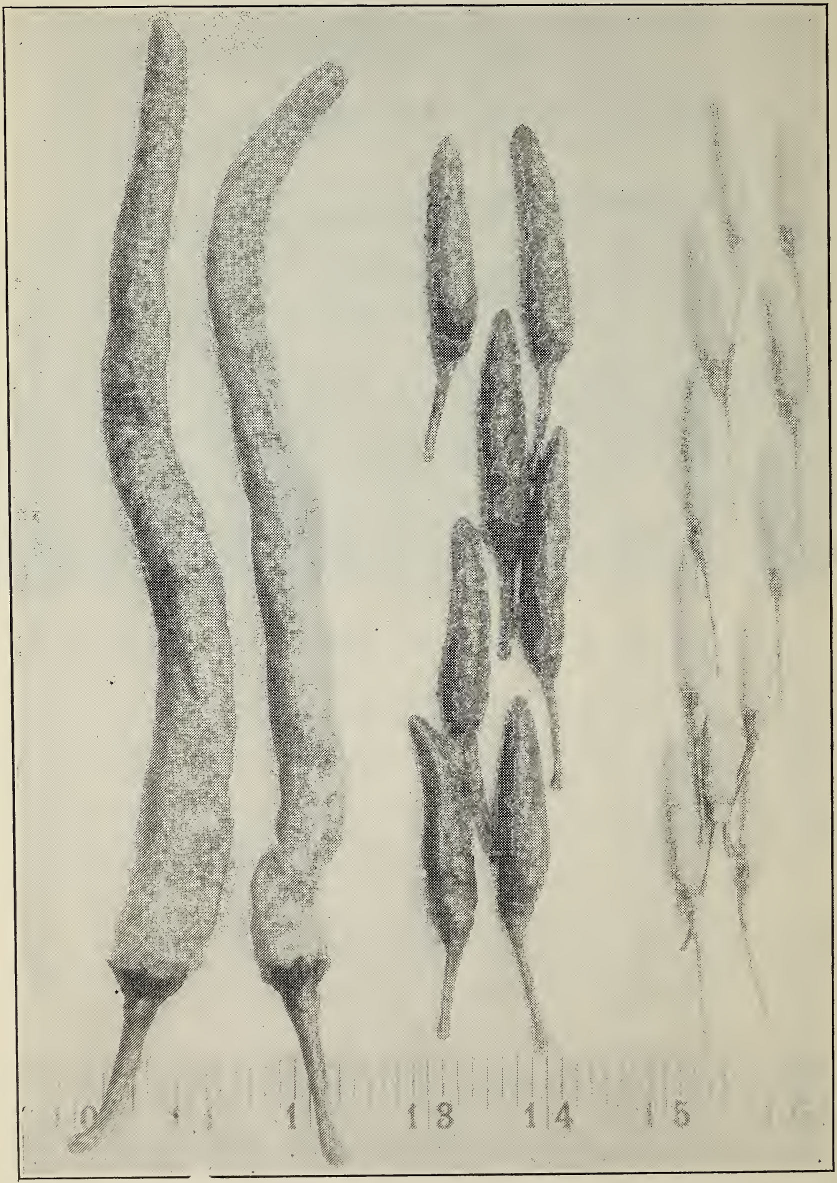

Figure 5. At the left is the Louisiana Cayenne No. 26; in the center is the Louisiana Sport; on the right are two strains of Tabasco, T-1, which is the long, and T-2, which is the short podded pepper.

Experiment Station. Work with three varieties, Cayenne, Sport, and Tabasco, has been done.

A variety of Cayenne pepper with a strong upright plant and a long, narrow, blunt-end pod that would separate from the calyx easily was wanted by the growers. The Sport pepper was badly mixed and a type with an upright, stout plant, having dark red, blunt-pointed pods about 2½ inches long and ½ inch in diameter, needed to be fixed. Two types of Tabasco were wanted: one with a sharp-pointed pod, and another with a blunt point. Satisfactory strains of the above varieties have been developed. See Fig. 5, which shows the relative shapes of the three varieties.

The growers have been supplied with seed of the above stocks and this year over 90 per cent of all the commercial hot pepper in Louisiana will be grown from the new and improved seed.

At the end of this season a full report of the work and a detailed description of the new strains will be published with the general release of the seed.

Another phase of this problem has been to make crosses and to study the mode of inheritance of some of the major characters found in hot peppers. It has been found also that hot varieties such as Cayenne, Sport, and Tabasco cross readily with each other as well as with varieties of sweet pepper such as World Beater, California Wonder, and Ruby King.

POTATOES, IRISH

The early Irish potato is one of the more important truck crops of Louisiana. Because of its importance in the State and because of the lack of information concerning it, the Louisiana Agricultural Experiment Station has devoted much time to this crop. Experiments on which to base recommendations for best cultural practices have been run. Experimental plots have been located at the Louisiana Agricultural Experiment Station and at Houma and Alexandria.

Extensive fertilizer tests have been conducted with Irish potatoes. That profitable increases in yields were obtained from the application of fertilizer is shown in Table 4. Other experiments indicated that the increase in yield from the heavier applications of fertilizer was due to nitrogen. As a result of the fertilizer tests conducted, the general recommendation for Irish potato fertilization in Louisiana is 800 pounds of 4-12-4 or 4-8-4 per acre, plus 160 pounds of sulphate of ammonia or equivalent within two weeks after the seed is planted. Organic sources of nitrogen were not found to be superior to inorganic sources. Ammonium sulphate is recommended as the source of nitrogen where scab is likely to be present as it is an acid-forming fertilizer and tends to reduce scab. When it is not desirable to apply a top dressing, all of the nitrogen may be applied before planting if it is from a source that does not leach too readily. Data concerning time of application of top dressing are given in Table 5. When no top dressing is to be applied, it is recommended that 8-12-4 or 8-8-4 be applied before planting. No significant differences in yields were found between plots fertilized with concentrated fertilizers and those treated with standard fertilizers. Tests on placement of fertilizer showed no significant differences in yields when fertilizer was applied at the rate of 800 pounds of 4-12-4 per acre.

The cost of seed is a big factor in the production of early Irish potatoes. For this reason the size of piece to plant is very important. Data on yields produced from different sized seed pieces are given in Table 6. The most economical size to plant ranged from 1 to 1.5 ounces.

TABLE 4. YIELDS OF POTATOES AND NET RETURNS FROM DIFFERENT RATES OF APPLICATION OF A 4-8-4 FERTILIZER.

Treatment (Rate of 4–8–4)	*Where Grown*	*Yield in Bushels per Acre*			*Increase of U. S. 1s in bu. per Acre from Use of Fertilizer*	*Value of Increase at 90c per bu.*	*Cost of Fertilizer per Acre*	*Value of U. S. 1s Less Cost of Fertilizer*
		U. S. 1s	*U. S. 2s*	*Culls*				
2000 lbs.	Houma	217.1	27.6	7.4	85.7	$77.13	$26.14	$50.99
1500 lbs.		215.5	29.5	6.6	84.1	75.69	19.50	56.19
1000 lbs.		193.1	32.1	9.1	62.7	56.43	13.07	43.36
800 lbs.		175.0	33.0	8.8	43.6	39.24	10.46	28.88
800 lbs. plus top dressing		224.3	30.9	9.0	92.9	83.61	14.45	69.16
600 lbs.		173.0	35.7	8.3	41.6	37.44	7.84	29.60
400 lbs.		153.0	37.4	8.8	21.6	19.44	5.23	14.21
000 lbs.		131.4	33.0	10.0	....	......	......	......
2000 lbs.	L. S. U.	169.0	40.9	18.8	91.9	82.71	26.14	56.57
1500 lbs.		151.8	45.2	21.3	74.7	67.23	19.50	56.19
1000 lbs.		135.9	42.1	19.2	58.8	52.92	13.07	39.85
800 lbs.		119.3	41.5	21.4	42.2	37.98	10.46	27.52
800 lbs. plus top dressing		129.3	42.3	21.9	52.2	46.98	14.45	32.53
600 lbs.		116.0	41.1	21.6	38.9	35.01	7.84	27.17
400 lbs.		98.3	43.6	22.8	21.2	19.08	5.23	14.85
000 lbs.		77.1	37.8	24.5	....	......	......	......
2000 lbs.	Alexandria	178.6	29.6	9.2	87.0	78.30	26.14	52.16
1500 lbs.		165.5	30.9	7.9	73.9	66.33	19.50	46.83
1000 lbs.		160.6	33.3	10.0	69.0	62.10	13.07	49.03
800 lbs.		143.5	32.6	6.6	51.9	46.71	10.46	36.25
800 lbs. plus top dressing		160.6	29.2	7.2	69.0	62.10	14.45	47.65
600 lbs.		131.4	32.4	6.8	39.8	35.82	7.84	27.97
400 lbs.		121.0	32.6	7.4	29.4	26.46	5.23	21.23
000 lbs.		91.6	24.1	6.0	....	......	......	......

TABLE 5. DATE OF APPLICATION OF TOP-DRESSING EXPERIMENT.
YIELDS IN BUSHELS PER ACRE.

Treatment*	Houma			Louisiana State University					
	Sulphate of Ammonia			*Sulphate of Ammonia*			*Nitrate of Soda*		
	No. 1s	*No. 2s*	*No. 3s*	*No. 1s*	*No. 2s*	*No 3s*	*No. 1s*	*No. 2s*	*No. 3s*
8-12-4	235.7	21.1	6.2	261.7	32.6	8.5	230.1	27.0	6.1
4-12-4 Top-dressed day of planting	248.2	20.5	5.5	254.6	30.2	6.7	248.8	29.6	7.8
4-12-4 Top-dressed 2 weeks after planting	247.1	19.6	4.6	267.9	29.0	6.8	259.2	27.3	7.0
4-12-4 Top-dressed when plants marked the row	216.9	21.4	4.9	254.6	26.2	7.0	242.6	30.1	7.6
4-12-4 Top-dressed 2 weeks after plants marked the row	214.5	22.2	4.8	244.1	28.3	5.9	241.1	24.5	6.2
4-12-4 No top-dressing	218.3	21.9	5.7	216.4	26.7	9.6	200.8	24.5	6.2
Check No fertilizer	162.9	22.6	4.8	145.2	30.9	5.5	130.3	25.6	4.9

*Fertilizer applied at the rate of 800 pounds per acre. Top-dressing 160 pounds per acre of sulphate of ammonia or equivalent.

TABLE 6. YIELDS OF POTATOES AND NET RETURNS FROM VARIOUS SIZES OF SEED PIECES. (12-inch spacing.)

Size of Seed Piece	*Where Grown*	*Yield in Bushels per Acre*			*Value of U. S. 1s at 90c. per bu.*	*Cost of Seed at $1.86 per bu.*	*Value of U. S. 1s Less Cost of Seed*
		U. S. 1s	*U. S. 2s*	*Culls*			
0.5 oz.	Houma..........	146.7	17.7	5.1	$132.03	$ 12.12	$119.91
1.0		200.9	26.0	5.6	180.81	24.24	156.59
1.5		215.5	34.2	6.2	193.95	36.36	157.59
2.0		223.5	31.8	7.8	201.15	48.48	152.67
2.5		230.1	42.4	11.7	207.09	60.60	146.49
0.5 oz.	L. S. U...........	104.9	21.2	9.0	94.41	12 12	82.29
1.0		136.5	29.1	10.7	122.85	24.24	98.61
1.5		151.6	41.4	18.1	136.44	36.36	100.08
2.0		145.1	43.7	20.2	130.59	48.48	82.11
2.5		148.8	51.2	25.4	133.92	60.60	73.32

Irish potatoes are often planted so early in parts of the State that it is not unusual for some vines to be injured or killed to the ground by frost. Very little information concerning recovery from frost damage was available, so this problem received some attention. It was found that the young plant rapidly uses up the reserve food in the seed piece. This was true even of large sized pieces, as is shown in Table 7. The effect of size of seed piece on recovery of plants cut to the ground is shown in Tables 8 and 9. It was found that plants from larger sized pieces recovered from injury better than those from smaller ones. When potatoes were the size of small marbles at the time vines were cut back, the production was very low even when the largest sized pieces were used.

TABLE 7. MOISTURE, SUGAR, STARCH, AND TOTAL NITROGEN CONTENT OF 2-OUNCE SEED PIECE BEFORE PLANTING AND AT INTERVALS DURING THE GROWING PERIOD.

State of Development	*Moisture %*	*Reducing Sugar %*	*Total Sugar as Invert %*	*Starch %*	*Total Nitrogen %*	*Height of Plant in Inches*	*Width of Plant in Inches*
Before planting....................	77.05	0.37	0.61	14.94	0.431	....	....
When plants marked the row.......	88.28	0.88	1.14	7.56	0.224	....	....
One week after plants marked the row......................	92.92	1.25	1.58	2.39	0.149	5.90	11.82
Two weeks after plants marked the row......................	95.67	0.90	0.94	0.91	0.096	9.70	17.38
Three weeks after plants marked the row......................	97.20	0.19	0.21	0.28	0.054	18.91	31.55

TABLE 8. EFFECT ON YIELDS OF SIMULATED FREEZE WHEN POTATOES WERE THE SIZE OF SMALL MARBLES. BUSHELS PER ACRE FROM DIFFERENT SIZES OF SEED PIECE. PLANTED JANUARY 15.

Size of Seed piece	*Vines Uncut*			*Vines Cut*		
	U. S. 1s	*U. S. 2s*	*U. S. 3s*	*U. S. 1s*	*U. S. 2s*	*U. S. 3s*
0.5 oz.	65.0	18.2	13.0	5.2	4.4	0.8
0.75 oz.	91.0	22.1	21.1	14.0	14.4	2.3
1.0 oz.	108.0	32.7	14.4	14.3	12.0	5.5
1.5 oz.	123.0	32.5	21.5	21.1	15.9	7.3
2.0 oz.	162.5	23.4	18.3	27.3	18.2	7.8

TABLE 9. EFFECT ON YIELDS OF SIMULATED FREEZE ONE WEEK AFTER PLANTS MARKED THE ROW. BUSHELS PER ACRE FROM DIFFERENT SIZES OF SEED PIECES. PLANTED FEBRUARY 21.

Size of Seed Piece	*Vines Uncut*			*Vines Cut*		
	U. S. 1s	*U. S. 2s*	*U. S. 3s*	*U. S. 1s*	*U. S. 2s*	*U. S. 3s*
0.5 oz.	118.3	14.3	7.8	22.1	7.0	2.1
0.75 oz.	145.3	17.4	10.4	57.2	15.6	5.7
1.0 oz.	163.8	18.7	8.1	48.1	12.6	3.6
1.5 oz.	209.7	24.4	17.1	115.4	30.6	12.3
2.0 oz.	215.7	39.6	25.1	118.8	33.8	14.3

The amount of seed used varies with the size of seed piece and planting distance. An experiment was run to determine the most economical spacing to use. In Table 10 are given the results of this experiment. The 14-inch spacing was found to be most economical and is generally recommended.

TABLE 10. YIELDS OF POTATOES AND NET RETURNS FROM VARIOUS PLANTING DISTANCES IN THE ROW. (1½-ounce seed pieces.)

Planting Distance	*Where Grown*	*Yield in Bushels per Acre*			*Value of U. S. 1s at 90c. per bu.*	*Cost of Seed at $1.86 per bu.*	*Value of U. S. 1s Less Cost of Seed*
		U. S. 1s	*U. S. 2s*	*Culls*			
8 in.	Houma.........	206.5	47.3	10.9	$185.85	$ 54.88	$130.97
10		210.4	39.3	10.4	189.36	43.82	145.54
12		207.6	33.9	8.6	186.84	36.36	150.55
14		216.0	30.9	8.8	194.40	31.19	163.21
16		196.3	30.2	8.6	176.67	27.44	149.30
8 in.	L. S. U.........	127.1	55.0	25.7	114.39	54.88	59.51
10		113.5	49.2	19.1	102.15	43.82	58.33
12		131.0	45.1	16.2	117.90	36.36	81.61
14		125.8	37.8	16.1	113.22	31.19	82.03
16		127.4	38.4	16.1	114.66	27.44	87.29

Usually the small sized potatoes, from 1½ to 1⅞ inches in diameter, should not be put on the market at the same time the larger sizes are shipped. They are often unprofitable and may help to flood the market and reduce the price of the better grades of potatoes. These good potatoes should not be a loss to the grower. It was thought that if they came from good seed stock, they should be good for planting in sections that plant in the fall to produce very early potatoes. Tests were run in several southern countries and in south Florida and very encouraging results were obtained. As a result of these tests, Louisiana certified Irish potatoes are now being produced. This seed must meet rigid specifications and is kept in cold storage from soon after digging until nearly time for shipment.

The work on Louisiana certified seed stimulated interest in keeping home-grown spring potatoes in cold storage until time for planting for the next spring's crop. Tests showed that this could be done with fair success. Better results were obtained with this type of seed than with fall-grown seed kept in common storage. To date, spring-grown cold storage seed of the Triumph variety has given more sprouts and plants that mature earlier and do not yield as much as northern-grown certified seed. Varieties vary in their ability to grow and produce normally after a cold storage period of eight to nine months. The problem of cold storage of home-grown seed potatoes is still receiving attention and it is hoped that the more serious problems can be satisfactorily solved.

Some growers are unable to buy northern-grown seed and cannot keep spring-grown potatoes in cold storage until the following spring planting. For this reason fall-grown seed is often planted to a limited extent in the State. When kept under common storage conditions, fall seed is slow to germinate and matures late in the season. Mosaic seems to be spread more extensively in the fall than in spring and plants from fall-grown seed are often badly infected with it. It has been found that by keeping diseased plants carefully rogued out in the fall the mosaic may be greatly reduced in plants grown the next spring from fall seed. If fall-grown seed is to be used, it should be produced from spring potatoes that came from the best stocks of certified seed. It has been found that plants produced from fall potatoes kept at high temperatures (65 to 75 degrees F.) from digging time until planting time will not be as slow coming up nor mature as slowly as those kept at lower temperatures. The effect of storage temperature on yield is shown in Table 11.

TABLE 11. YIELDS OF IRISH POTATOES FROM FALL-GROWN AND WESTERN CERTIFIED SEED. (2-year Average.)

Source of Seed	*Yields in Bushels per Acre*					
	Grown at L. S. U.			*Grown at Houma*		
	U. S. 1s	*U. S. 2s*	*Culls*	*U. S. 1s*	*U. S. 2s*	*Culls*
Fall—High Temperature	171.3	24.9	9.9	173.3	14.5	9.9
Fall—Common Storage	127.7	16.5	9.4	109.8	13.7	3.3
Western Dryland Certified	224.7	32.9	9.4	216.4	21.7	6.1
	Grown at Alexandria			*Average*		
Fall—High Temperature	143.3	18.3	8.1	162.6	19.2	9.3
Fall—Common Storage	86.3	18.8	8.1	107.9	16.3	6.9
Western Dryland Certified	229.4	21.4	9.0	223.5	28.7	8.2

Rainfall is the biggest limiting factor to the production of fall Irish potatoes in Louisiana. Good fall crops usually can be produced in many parts of the State, however. It has been found that fall potatoes should not be planted too early if good yields and well shaped potatoes are to be produced. September 1 seems to be the best planting date in south Louisiana. When the potatoes had been kept at normal temperatures after digging, only No. 2 whole tubers gave good germination, but when kept in cold storage, No. 1 cut potatoes were very satisfactory.

For several years the Louisiana Agricultural Experiment Station cooperated with the United States Department of Agriculture in their tuber unit disease reading investigations and the trial of new seedlings. The testing of promising seedlings is still being conducted. The behavior of the Houma variety in Louisiana emphasized its value and had much to do with the selection of its name.

Due to the advantages of breeding a crop especially adapted to conditions under which it is to grow, a breeding project with Irish potatoes has been set up at the Louisiana Agricultural Experiment Station. Climatic conditions facilitate the breeding of this crop here and no similar work has been done in the South. The ability to produce two crops of potatoes in the open in a year gives Louisiana a distinct advantage in its potato breeding program. The commercial varieties now used in Louisiana were developed in the New England States. It is hoped to develop a high yielding, high quality, disease resistant potato that does not lose its vigor in storage and is especially adapted to our climatic conditions.

POTATOES, SWEET

The most important vegetable crop grown in Louisiana is the sweet potato. In 1936 this State ranked first in the United States in total production of sweet potatoes, with 7,797,000 bushels, and in carlot shipments, with 2650 cars. This important crop has not received the attention from southern research workers that its value to the South justifies. Several experimental projects have been and are being conducted with it at the Louisiana Agricultural Experiment Station.

Table 12. Rate of Application of Complete Fertilizer Test (4-8-4).
3-year Average.

Rate of Application, Pounds per Acre	*Where Grown*	*Yield in Bushels per Acre*				*Total Yield*	*Increase of U. S. 1s in bu. per Acre from Fertilizer*
		Jumbos	*U. S. 1s*	*U. S. 2s*	*Culls*		
1000	Sunset.........	9.4	300.0	45.7	47.8	402.9	78.2
800	Sunset.........	17.4	276.9	44.9	45.1	392.5	54.2
600	Sunset.........	7.1	284.2	42.7	44.1	378.1	62.4
400	Sunset.........	10.6	273.2	44.1	45.5	373.4	51.4
200	Sunset.........	6.0	252.5	48.2	48.7	355.4	30.7
000	Sunset.........	1.8	221.8	47.7	41.4	312.7	....
1000	L. S. U.........	87.0	401.1	41.6	23.3	553.0	80.1
800	L. S. U.........	71.6	378.7	40.9	24.3	515.5	57.7
600	L. S. U.........	64.1	361.1	36.8	20.6	482.6	40.1
400	L. S. U.........	44.9	371.7	38.4	23.3	478.3	50.7
200	L. S. U.........	33.3	356.2	37.1	21.1	461.8	35.2
000	L. S. U.........	50.3	321.0	34.7	18.8	424.8	....

Cultural experiments were conducted at the Louisiana Agricultural Experiment Station and at Sunset, Louisiana. The results of fertilizer experiments showed that sweet potato yields were increased by the application of commercial fertilizers. This is shown in Table 12. Phosphorous gave the greatest response in yield of any of the fertilizer elements tested. Small amounts of nitrogen were beneficial, but the application of potash was of doubtful value on the soils used in these experiments. From 400 to 600 pounds of 4-12-4 or 4-8-4 per acre is the application of fertilizer that is recommended, in general, for Louisiana. The potash applied may, in some cases, be of no value to the sweet potato crop, but on some soils it will be beneficial and its cost will not be great. Unless home mixing of fertilizers is practiced, complete fertilizers are usually more easily obtained.

Results on spacing tests are shown in Table 13. The 12-inch spacing was found to be best and is generally recommended for the commercial producing districts of Louisiana. The rows should be 3½ to 4 feet apart.

TABLE 13. SPACING TEST. 3-YEAR AVERAGE.

Distance Apart in the Row	*Yield in Bushels per Acre*				*Total Yield*
	Jumbos	*No. 1s*	*No. 2s*	*Culls*	
9 inches	32.1	338.4	33.6	26.9	431.0
12 inches	41.2	373.6	36.3	25.4	476.5
15 inches	34.5	357.5	35.2	23.2	450.4
18 inches	62.8	319.6	28.0	20.8	431.2
21 inches	59.3	308.0	27.9	17.6	412.8

The Porto Rico sweet potato is quite variable in shape. It was found that neither fertilizer treatment nor the shape of potatoes bedded had any influence on the shape of potatoes produced. As shown in Table 14 and Figure 6, the shape of sweet potatoes of the Porto Rico variety was found to be greatly influenced, however, by the time of setting slips or cuttings to the field. The earlier the plants are set in the field, the more chunky will be the potatoes produced; the later the plants are set, the greater will be the length of the potatoes. Tests to compare the influence of vine cuttings and slips showed that these had no effect on the shape of Porto Rico sweet potatoes produced. The best time for setting plants in the field in the commercial areas of south Louisiana appears to be early in June, to obtain the largest percentage of potatoes of the most desirable shape. The date of planting potatoes has much to do with the yield produced, as the data in Table 15 show. The earlier

TABLE 14. EFFECTS OF DATE OF PLANTING ON THE SHAPE OF SWEET POTATOES

Time of Planting	*L/D Ratio*	*Average Length (Cm)*	*Average Diameter (Cm)*
Early, May 6, 1932	1.57 ±0.014	12.14	7.74
Late, July 15, 1932	2.78 ±0.024	17.15	6.16
Early, April 20, 1933	1.33 ±0.023	10.72	8.06
Late, June 15, 1933	2.23 ±0.039	13.79	6.18

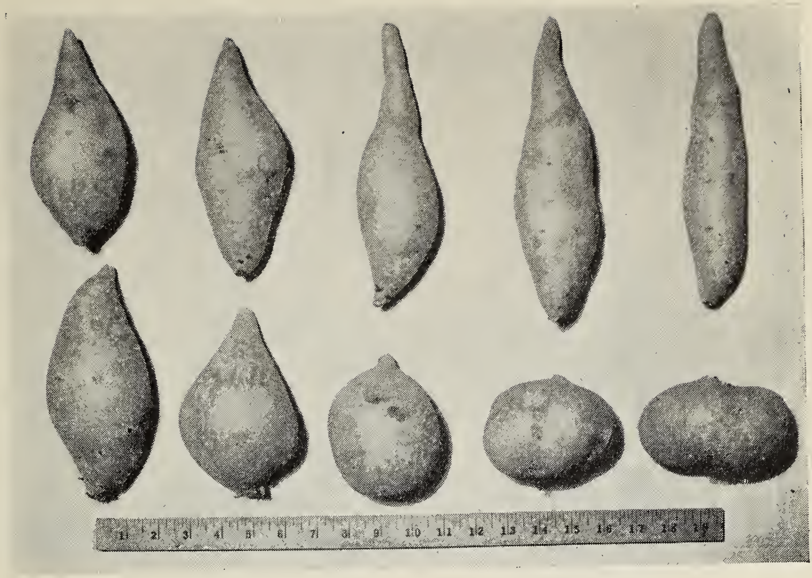

Figure 6. Lower row—Potatoes from early planted lot. Upper row—Potatoes from late planted lot.

TABLE 15. EFFECT OF PLANTING DATE ON TOTAL YIELD OF SWEET POTATOES

Planting Date	*Date of Harvest*	*Total Yield in Bushels per Acre*
May 15.........	October 24............	686.1
June 10.........	November 15..........	458.1
July 23.........	November 19..........	259.2

the planting date, the heavier will be the yield. Total yield is not the only consideration in growing potatoes to be shipped, however, as here the yield of fancy No. 1 potatoes is of primary importance. Early planting does not produce the largest percentage of fancy potatoes. Potatoes from plants set to the field very early do not seem to keep in storage as well as those from plants set out later.

Storage of sweet potatoes is very important, as the late crop is stored for several months. Curing with artificial heat has been considered an essential to proper storage; however, weather conditions in south Louisiana during October are such that artificial heat for curing should not be necessary, since it is usually a dry month and the temperature is relatively high. Experiments were conducted in which sweet potatoes cured with artificial heat were compared with those where none was used. It was found that artificial heat was not necessary for curing sweet potatoes in south Louisiana, nor was it necessary for storage. Data on shrinkage and loss from rot under both plans are given in Table 16.

Table 16. Shrinkage and Loss from Rot in Sweet Potatoes Cured and Stored Where Artificial Heat was Used Compared with that in those Where No Artificial Heat was Used

Year	Date of Harvest	Treatment	Shrinkage During Curing. Per cent	Shrinkage for Storage Period. Per cent	Length of Storage Period		Loss from Rot at End of Storage Season. Per cent
					Mos.	Days	
1930–1931	Nov. 7	Artificial heat................		14.00	4		.56
		No artificial heat............		13.90			.43
1931–1932	Oct. 22	Artificial heat................	6.14	15.04	4	11	11.53
		No artificial heat............	6.93	14.50			11.60
	Dec. 7	Artificial heat................	5.71	9.77	2	27	.46
		No artificial heat............	3.16	9.48			2.96
1933–1934	Oct. 10	Artificial heat................	4.53	10.86	4		6.76
		No artificial heat............	4.80	11.79			7.26
	Nov. 2	Artificial heat................	6.52	11.68	3	10	7.44
		No artificial heat............	4.41	10.62			1.15
1934–1935	Oct. 26	Artificial heat	6.23	11.82	3	10	2.00
		No artificial heat............	6.97	12.08			2.79
	Nov. 17	Artificial heat................	4.87	10.03	2	18	2.55
		No artificial heat............	3.61	8.52			1.50

A study of the Porto Rico variety of sweet potatoes disclosed the fact that mutations occur with relative frequency in the potato fields of Louisiana. Where seed potatoes are bedded without proper selection, mutations increase and the potatoes become so badly mixed that often the grower concludes that his potatoes have run out. Some of the mutations sprout earlier than the normal Porto Rico and where early slips have been set to the field to produce plants for vine cuttings, mutations have been abnormally increased. To keep the variety pure it is recommended that seed potatoes be carefully examined before bedding and that only those having the desired skin and flesh color be used. The interior color may be examined at bedding time by taking a chip from the end which is sprouting.

Six distinct types of mutations in the Porto Rico variety of sweet potato have been found. These are described and named as follows:

Porto Blanco: This is the most common type of mutation that has been found in Porto Rico potatoes. It is easy to recognize since it has white to cream-colored skin and is generally larger, coarser, and more nearly oblong than normal potatoes. The flesh is creamy white and almost tasteless. Some of these white mutations have normal vines while others produce larger and more vigorous vines, longer petioles, and have less purple color than the normal plants. This potato sprouts earlier and requires a longer period for maturing than its parent. It is a good potato for livestock and offers possibilities for the manufacture of starch.

Porto Rubio: Potatoes of this type are rather hard to recognize since the skin color is practically the same as that of the parent. They have more side roots and are more nearly oblong than the Porto Rico. The potatoes have white to creamy flesh which is practically tasteless, resembling the flavor of an Irish potato.

This mutant sprouts, matures, and has a vine growth very similar to that of the Porto Blanco.

PORTO MORADO: This potato differs from the normal in that it has purple color that is confined to the epidermis, a deeper purple vine color, is slightly earlier in maturing, and sprouts later in storage than its parent. Several reversions to the parent Porto Rico have been noted in this strain. The fading out or disappearance of the purple color has been pronounced during seasons of excessive rain. From available information, it appears that this particular type of mutation was first grown in Georgia. Plant and seed growers have distributed this potato to various parts of the country and have sold it under the following names: Improved Porto Rico, Purple-skin Porto Rico, and Red Porto Rico. We have found two mutations similar to the Georgia strain.

PORTO ORADO: This particular mutation was first described by the Coker Pedigreed Seed Company in their 1926 catalog. The shape of most of these potatoes is short fusiform to globular, or shorter than the Porto Rico when grown under comparable conditions. The skin is a light golden color. A number of mutations of this type have been found.

PORTO MATOSO: This Vineless or Bunched type potato was found and propagated by J. B. Wilson of Gadsden, Alabama. In all characteristics except the shortness of the vine, it resembles the Porto Rico. The internodes are about 1 inch long in the Vineless, while those of the Porto Rico are about 5 inches long. In tests so far, the Vineless has not produced as high yields as the Porto Rico.

INDUCED MÜTATION: A mutation that was induced by X-Ray and resembles one of the natural mutations, the Porto Rubio. The chief difference between the two is that the induced mutation has a sweeter taste than the natural one.

Since mutations that affect the color and composition of the roots occur frequently with the Porto Rico variety in Louisiana and since variations in type of vine growth are known, it seemed possible that variations affecting other characters might be found. With this in mind an attempt was made to find a high yielding strain. The experiment was started with 14,000 hills of Porto Rico sweet potatoes from several sources. These hills were dug separately and the highest yielding hills were selected for further study, one root from each selected plant being used for propagation purposes. Rigid selection was practiced over a period of 6 years and one strain has been selected as outstanding. This strain is known as the "Unit One Porto Rico" in Louisiana. Where it has been tried to date it has performed in a manner than has been more than satisfactory. Wherever it has been grown in comparison with local sources of Porto Rico potatoes it has given far better yields. Except for sprouting earlier and producing more early plants, there is no way of distinguishing between Unit 1 and the regular Porto Rico. Whether Unit 1 is a higher yielding mutation of the Porto Rico variety is not definitely known, but it is believed to be the best source of Porto Rico seed available at present. The sweet potatoes certified by the Louisiana Pure Seed Growers Association are exclusively of this variety. About 2000 bushels of this strain were certified in 1936.

SNAP BEANS

Snap beans are grown as a truck crop in Louisiana both in the spring and in the fall. A study of the best cultural practices and a variety test have been conducted with this crop. Experimental plots were located at the Louisiana Agricultural Experiment Station for both spring and fall crops and additional work was conducted at Houma in the spring.

The results of fertilizer experiments with spring-grown beans indicated that 200 to 400 pounds of 4-8-4 per acre on a 3½-foot row basis was sufficient, the heavier application being necessary on the poorer soils. Experiments at Hammond showed that 600 pounds per acre might not be too much in that section. In the fall excellent crops of beans were produced without fertilizer on soil that had been fertilized for other crops for a number of years when the beans followed a cover crop of soybeans turned under. The yields were reduced in proportion to the amount of fertilizer applied. This is shown in Table 17. While working with fertilizer tests with beans, it was noticed that the fertilizer applied might delay germination and, in case of the heavier applications, reduce the stand. To get more information on this subject, some studies on the placement of fertilizer were made. It was found that bean seed were injured by fertilizer placed under them even to a depth of 4 inches, while the same rate of application placed in bands at the side was not injurious, regardless of the depth of the bands of fertilizer. Where more than 200 pounds of fertilizer per acre is applied to beans, it is safer to apply it in bands at the sides of the bean seed.

TABLE 17. EFFECT OF FERTILIZER TREATMENT ON YIELD OF SNAP BEANS IN THE FALL. (3-year Average.)

Nitrogen Test			*Phosphorus Test*		*Potash Test*		*Rate per Acre* 4–8–4	*Yield per Acre in Bushels*
Treatm't 800 lbs. per Acre NPK		*Yield per Acre in Bushels*	*Treatment NPK*	*Yield per Acre in Bushels*	*Treatment NPK*	*Yield per Acre in Bushels*		
6–8–4		92.2	4–16–4	106.9	4–8–6	116.8	1200 lbs.	79.7
6–8–4	(N. as top dressing*)	127.1	4–12–4	112.4	4–8–4	119.3	1000 lbs.	85.2
4–8–4		113.9	4–8–4	109.0	4–8–2	112.4	800 lbs.	101.8
4–8–4	(N. as top dressing*)	131.8	4–4–4	119.0	4–8–0	122.2	600 lbs.	103.6
2–8–4		126.3	4–0–4	108.1	0–0–0	164.4	400 lbs.	117.3
2–8–4	(N. as top dressing*)	131.4	0–0–0	160.1			200 lbs.	130.5
0–8–4		154.8					000 lbs.	143.1
0–0–0		163.4						

*2-Year average.

The seed for planting requires the greatest cash outlay in putting in a crop of beans. Therefore, planting distance is an important factor in bean production. Data on effect of planting distance on yield of snap beans are given in Table 18. The 2-inch spacing is believed to be the most economical, but the grower may use his own judgment as to whether he wants to plant seed closer together and get larger yields or farther apart and get a greater total yield for a given amount of seed. This will vary with the land and labor available and with the amount the grower can spend for seed.

In the variety test, the Bountiful, Burpee's Stringless Greenpod, and Giant Stringless Greenpod gave highest yields of the green type, and Currie's Rust Proof Wax was the highest yielder with Sure Crop Stringless Wax second among the wax varieties.

TABLE 18. EFFECT OF PLANTING DISTANCES ON YIELD OF SNAP BEANS.
(Average of Four Crops.)

Planting Distance		*Yield in Bushels per Acre*	*Pounds of Seed per Acre. 3½-foot Row Space*	*Cost of Seed at 10c. per Pound*
Drill system—				
1 inch		139.2	125	$12.50
2 inch		124.8	65	6.50
3 inch		107.3	41	4.10
4 inch		96.3	31	3.10
5 inch		84.0	25	2.50
Hill system—				
Interval:	*Number of Seed*			
6 inch	3	118.2	65	6.50
12 inch	6	109.2	65	6.50
6 inch	2	98.3	41	4.10
12 inch	4	105.5	41	4.10
12 inch	3	89.8	31	3.10

SQUASH

White Bush or Patty-Pan is the leading squash for home and commercial use in this State. This squash has many defects, particularly its rough lobed margins and its varying shapes. In order to add quality and depth to the fruit, crosses were made between the White Bush variety and the Table Queen. A number of selections

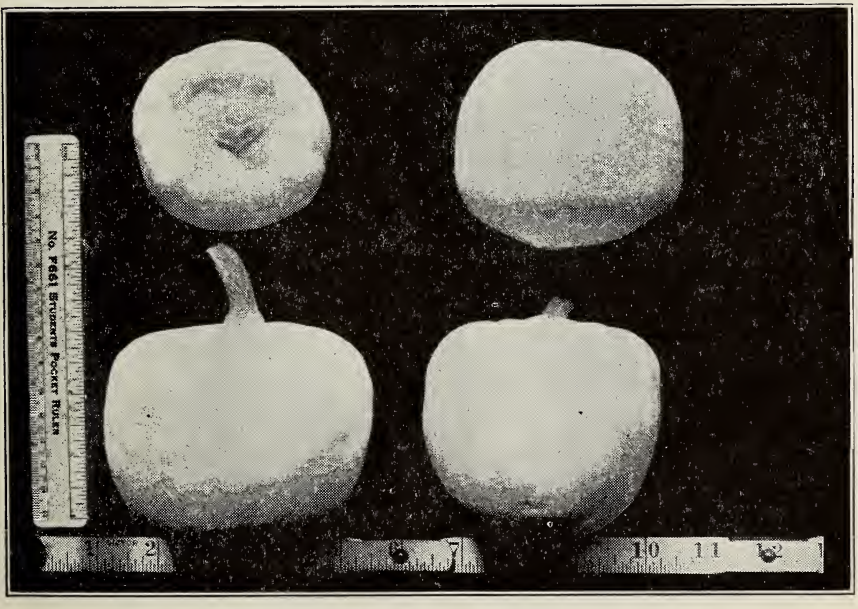

Figure 7. Showing the general shape of the Louisiana Sugar Bowl squash.

have been made from this cross for white color and deep to globe-shaped fruit. (See Fig. 7.) The variety will be known as the LOUISIANA SUGAR BOWL. Fruit of this shape may be used in a greater number of ways, particularly for baking and stuffing or for slicing, than the old White Bush. Advanced field and shipping tests will be conducted with this variety next season.

STRAWBERRIES

The strawberry is the most important fruit crop in Louisiana and any work to aid this industry would be significant. While the Klondike was developed in Louisiana and is the most important variety in the United States, the fact remains that it has a number of defects. There is need for a berry of better eating quality and more resistant to leaf spot and scorch diseases. Breeding work was started three years ago at the Louisiana Agricultural Experiment Station and is being expanded each season. Crosses are made between Klondike and the major varieties and seedlings that are higher in quality and more disease-resistant but that do not possess the better qualities of the Klondike. While the breeding work has been in progress only two years, several seedlings that are superior to the Klondike in many respects, particularly in disease resistance, have been found.

The general plan of breeding is to grow about 3000 seedlings each year. The seed are sown about January 1 in flats that are kept in the greenhouse. About March 15 the seedlings are transplanted to 3-inch pots and placed in the lath-house until fully rooted, which takes about ten days. At this time the potted plants are shifted from the lath-house to open beds. The pots are plunged to the rim in soil. From this time on, they are sprayed at frequent intervals with a spore suspension of the leaf spot and scorch diseases. By June 15, when it is necessary to shift the plants to the nursery, it has been possible to discard most of the susceptible plants and the original number has been reduced from 3000 to 250 to 500 plants. The plants are set to the nursery on level rows spaced 6x6 feet. Throughout the summer they are sprayed at monthly intervals with the diseases as mentioned above. The number of plants that survive the diseases and summer heat, and which produce satisfactory runners, is usually about 50 per cent of the number originally set to the nursery in June. By October, each of the better seedlings has produced from 200 to 300 runner plants. For the first year's fruiting test, 40 of the better plants from each seedling are planted at Louisiana State University and at the Fruit and Truck Experiment Station, Hammond, Louisiana. The second and third years' studies are more comprehensive and include such studies as yield, chemical, and shipping tests.

TOMATOES

While a number of varieties of tomatoes are fairly well suited to Louisiana conditions, none of them is entirely satisfactory. A number of crosses have been made, using such varieties as Louisiana Pink and Louisiana Red crossed with Break-O'-Day and Walter Richard as parents. From several hundred seedlings, the number has been reduced to the four best. Of the remaining four, two in particular are very outstanding. These two selections are very high in quality, early, and resistant to wilt and cracking. One of the strains shows some resistance to blight. These strains are being tested in the tomato districts of this State and in the major districts of the United States. Present plans are to release one of these new seedlings, known at present by the stock number 10-4, for the 1938 spring crop. At that time it will be named and described in detail. See Fig. 8, which shows the general shape of the 10-4. It is a cross between the Louisiana Pink and the Walter Richard. The tomatoes are large, firm, and pink, and have comparatively few small seed.

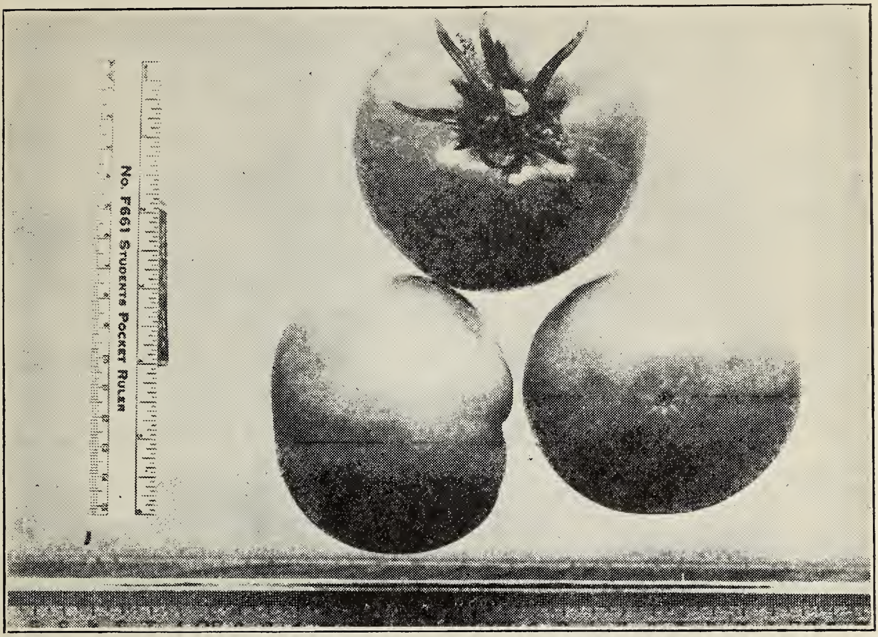

Figure 8. 10-4 tomatoes from three different planes. Note the russet streaks about the stem, a characteristic of this variety.

TUNG TREES

Interest in tung trees is increasing rapidly in Louisiana. Several thousand acres have already been planted to these trees, with the prospect of many more being planted in the near future. Since no experimental work has been done in this State to answer the questions of interested persons, the Louisiana Agricultural Experiment Station started work with this crop in the spring of 1933. Fertilizer plots were laid out in a grove, one year old from seed, near Isobel, Louisiana, on property belonging to the Great Southern Lumber Company. In the spring of 1936 a more extensive fertilizer experiment was started on property of the same company in a grove that had just been transplanted between Covington and Bogalusa. The fertilizer applied has given striking results in tree growth in both groves and in yield of nuts the one year a crop was produced, in 1936, in the older planting. In the older grove the application of phosphorus gave the largest increase in growth, with nitrogen also giving a good increase and potash being of little value. In the younger grove all three fertilizer elements seem necessary for best growth. Based on the results obtained to date, the fertilizer recommended for tung trees is one pound of 4-8-4 per tree for each year of age of the tree until it is four years old, after which the yearly application of four pounds per tree should be continued.

Present lack of uniformity of trees in the tung plantings is a major problem. Another important problem in Louisiana is injury to flower buds from late freezes in the spring. To try to overcome these problems, nuts from high producing trees that produced a crop the year of a late freeze have been planted to test the value of such selection. Seedling trees have been budded from selected trees. It is hoped that uniform annual bearing trees may be selected. A start has been made in the attempt to establish a pure line of uniform, desirable, annual bearing trees. This may take a number of years to accomplish, but if it can be done it will be of the greatest benefit to those interested in tung oil production in this country.

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LOUISIANA BULLETIN NO. 288 JULY, 1937

Investigations on Sugar Cane Diseases in Louisiana in 1936-1937

Louisiana State University
and
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

C. T. Dowell, *Director*

INVESTIGATIONS ON SUGAR CANE DISEASES IN LOUISIANA IN 1936-1937

I. Losses caused by the mosaic and red rot diseases of sugar cane.
C. W. Edgerton, I. L. Forbes, and P. J. Mills

II. Possible migration of spores of red rot fungus in cane stalks.
R. E. Atkinson and C. W. Edgerton

III. Immunity studies with sugar cane mosaic.
I. L. Forbes, P. J. Mills, and C. W. Edgerton

I. LOSSES CAUSED BY THE MOSAIC AND RED ROT DISEASES OF SUGAR CANE

C. W. EDGERTON, I. L. FORBES, AND P. J. MILLS

As sugar cane varieties are constantly changing in the State, it is necessary to keep an accurate record each year of the disease reaction of the different commercial and promising canes that are planted. Definite information regarding the resistance or susceptibility of all the varieties to the different diseases becomes very important at that time each year when it is necessary to make recommendations regarding the release of new varieties, the possible abandonment of any of the old ones, and the location and acreage in the State that should be planted with each variety. It is necessary to obtain this information each year because, as is generally recognized at the present time, the susceptibility of a variety to a disease may change from year to year. When such information is available and a variety is known to be slowly losing its resistance to a certain disease, it can gradually be dropped before the planters have suffered any losses.

Continuing the work which has been in progress for a number of years, the various commercial canes and many of the new seedlings have been tested in field plats at Baton Rouge during the past two years. The object of these tests was to obtain some information on the maximum loss which could be expected from the mosaic and red rot diseases. The information which has been procured is presented in a series of tables in this bulletin. From this information it is possible to draw some very definite conclusions and make some recommendations applicable to the immediate future.

EFFECTS OF MOSAIC ON YIELD

The results obtained from field tests of two years which were planned primarily to determine the effect of the mosaic disease on the yield of the different commercial varieties are of considerable interest. One test was started in the fall of 1934, and from this results were obtained on both plant and stubble cane. From the other test, which was started in the fall of 1935, yields of plant cane have been obtained. In both tests, seed cane 100 per cent infected with mosaic was planted in plots and compared with others planted with seed cane free of the disease. Such tests should give the maximum effect of the disease.

I. *Effect of mosaic on yield of plant and stubble cane, 1935 and 1936:* In the fall of 1934 replicated plots at Baton Rouge were planted with mosaic-infected and mosaic-free seed cane. Each plot consisted of a section of a row fifty feet in length and was planted with 250 good eyes. The plant cane was harvested on November 17-18, 1935, and the stubble cane on October 27-28, 1936. The yields obtained are included in table 1.

TABLE 1. YIELDS OF PLANT AND STUBBLE CANE IN PLOTS PLANTED IN THE FALL OF 1934 USING MOSAIC-INFECTED AND MOSAIC-FREE SEED CANE

Variety	Condition of Seed Cane	Number of Replications	Yield of Plant Cane Nov. 1936 Tons per Acre	Yield of Stubble Cane Oct. 27-28, 1937 Tons per Acre
Co. 281 . . .	Mosaic-free	8	34.3	26.1
Mixed Soil .	Mosaic-infected .	8	32.2	23.2
Co. 281 . . .	Mosaic-free	4	22.7	22.8
Heavy Soil .	Mosaic-infected .	4	21.9	20.8
Co. 290 . . .	Mosaic-free	4	59.3	50.4
	Mosaic-infected .	4	49.5	36.2
C.P. 28-19 . .	Mosaic-free	4	36.3	29.0
	Mosaic-infected .	4	31.5	29.0
C.P. 29-291 .	Mosaic-free	3	41.0	33.2
	Mosaic-infected .	3	35.2	30.2
C.P. 29-320 .	Mosaic-free	4	37.0	30.1
	Mosaic-infected .	4	38.4	28.8

In general, with the exception of Co. 290, the results obtained in this test are in agreement with those obtained in previous years. It is important to note that the losses caused by mosaic to the stubble crop were no greater than to the plant cane.

II. *Effect of mosaic on yield of plant cane, 1936.* In the fall of 1935, replicated plots were planted with mosaic-infected and mosaic-free seed as in the previous year. Each plot was a section of a row fifty feet in length, and was planted with 200 good eyes. The plots were harvested on December 8-9, 1936. The yields obtained are included in table 2. On account of the impossibility of obtaining sufficient mosaic-infected seed cane, the important varieties C.P. 28-11, C.P. 29-320, and C.P. 29-116 were not included in this test.

TABLE 2. YIELDS OF PLANT CANE IN PLOTS PLANTED IN THE FALL OF 1935, USING MOSAIC-INFECTED AND MOSAIC-FREE SEED CANE, HARVESTED DECEMBER 8-9, 1936.

Variety	Condition of Seed Cane	No. of Replications	Germination Percentage May 11-13	Yield Tons per Acre	Sucrose
Co. 281 . . .	Mosaic-free . . .	5	23.0	33.6	10.46
Mixed Soil .	Mosaic-infected .	5	22.2	30.6	11.23
Co. 281 . . .	Mosaic-free . . .	5	28.4	25.26	12.84
Heavy Soil .	Mosaic-infected .	5	22.3	20.46	12.84
Co. 290 . . .	Mosaic-free . . .	5	44.3	54.5	9.59
Mixed Soil .	Mosaic-infected .	5	40.3	50.7	8.74
C.P. 28-19 . .	Mosaic-free . . .	5	26.0	38.12	13.84
	Mosaic-infected .	5	24.0	38.64	13.52

The results obtained with plant cane in 1936 were quite similar to those obtained in previous years. With none of the varieties tested were losses appreciably greater than in previous tests.

DISCUSSION OF MOSAIC TESTS

Several things of interest are shown in the results from the field tests. In figuring the actual importance of the mosaic disease at least three things must be taken into consideration: (1) the actual loss resulting when 100 per cent of the plants are infected and all remain infected through the growing season; (2) the resistance shown by a variety to infection; and (3) the ability shown by the plants of certain varieties to throw off the disease. Reduction in yield of infected plants may be very marked, yet the plants of a variety may be so resistant to infection or they may have the ability to recover to such a marked degree that the actual number of infected plants in the field may be small. When this condition occurs a few badly stunted stools will be observed, yet the actual reduction in yield of a whole field may be very slight. These points are considered in the following discussion.

1. *Actual reduction in yield from mosaic.* Results on the effect of mosaic on reduction in yield of some of the commercial canes have been obtained for several years. In all cases the data were procured from plots planted with mosaic-infected seed cane and should show the maximum effect from the disease. Data obtained at Baton Rouge are given in table 3.

Table 3. Reduction in Yield (per cent) in Plant Cane from Mosaic at Baton Rouge

Variety	Soil	1933	1934	1935	1936
Co. 290	Mixed Soil		0.8	16.5	6.9
Co. 281	Mixed Soil	0.8	9.2	6.1	8.9
Co. 281	Heavy Soil			3.5	19.0
C.P. 28-19	Mixed Soil			13.2	+1.3*
C.P. 29-320	Mixed Soil			+3.8*	
C.P. 29-291	Mixed Soil		32.9	14.1	
C.P. 28-70 (green mosaic)	Mixed Soil			12.1	
C.P. 28-70 (yellow mosaic)	Mixed Soil	31.8	61.4	49.5	

* Increase in yield.

One thing of particular importance is brought out by the results presented in the above table. The very valuable varieties Co. 281 and Co. 290 are injured by the mosaic disease but the losses are not becoming greater from year to year. There is also nothing to indicate that the losses will be any greater in the immediate future.

2. *Varietal resistance to mosaic infection.* Plants of some varieties do not become infected with mosaic as readily as others and also some throw off the disease after becoming affected. When considering the actual effect of the disease on any variety, it is very important to know the percentage of the disease that ordinarily occurs in fields which have been planted with both mosaic-infected and mosaic-free seed cane. During the past two years such information has been obtained in the plats at Baton Rouge. This information is presented in table 4.

A study of the above table will show that the varieties fall into three groups.

1. *Those varieties which become infected readily and do not throw off the disease after becoming infected.* Such varieties show the most unsatisfactory behavior towards mosaic. In this group are found the varieties Co. 281, Co. 290, and C.P. 29-291. It should be noted that Co. 290 does not become infected as easily or as quickly as Co. 281. The seedling C.P. 29-291, although a very desirable cane in many respects, will probably never be released, for no other reason than that it falls in this group.

TABLE 4. PERCENTAGE OF MOSAIC-INFECTED PLANTS IN PLOTS PLANTED WITH MOSAIC-INFECTED AND MOSAIC-FREE SEED CANE AT BATON ROUGE

Variety	Percentage Mosaic June 11, 1936 in Plats Planted with		Percentage Mosaic Sept. 12, 1936 in Plats Planted with	
	Mosaic-free Seed Cane	Mosaic-infected Seed Cane	Mosaic-free Seed Cane	Mosaic-infected Seed Cane
Co. 281—Mixed Soil	9.5	87.8	14.0	100.0
Co. 281—Heavy Soil	2.4	99.2		
Co. 290	0.4	99.8	10.2	99.9
C.P. 29-291	8.6	91.5		
C.P. 28-11			0.1	99.9
C.P. 28-19	0.0	50.9	0.0	21.8
C.P. 29-320	0.0	40.9	0.0	2.0

2. *Those varieties which do not become infected readily but do not throw off the disease after becoming infected.* The mosaic could probably be controlled very readily in such varieties by rogueing. In this group the variety C.P. 28-11 should apparently be placed.

3. *Those varieties which do not become infected readily and also readily throw off the disease after becoming infected.* Varieties in this group show the most satisfactory behavior towards mosaic. Rogueing should control the disease readily in these varieties and probably even this would not be necessary. In this group are found the, at present, very valuable varieties C.P. 29-19 and C.P. 29-320.

EFFECTS OF RED ROT ON GERMINATION AND YIELD

Field tests to determine to what extent the red rot disease can reduce the yields of the important cane varieties have been conducted during the past two years at Baton Rouge.

The most serious effect of the red rot disease is the killing of the buds on the seed cane. This means poorer germination, poorer stands in the field, and, generally speaking, decreased tonnage at harvest time.

In the tests at Baton Rouge, the stalks selected for planting were inoculated at planting time with a pure culture of the red rot fungus. Each stalk was punctured with a specially made steel inoculator which left a clean cut hole into the center. In this hole was placed the pure culture. Each stalk was inoculated in two to three places, depending on its length. Plats were planted with these inoculated stalks and others were planted for comparison with punctured but not inoculated stalks. In the spring the germination was obtained and in the fall the cane was harvested and weighed.

The tests were conducted in a similar manner in both years. Each plat consisted of a section of a row, fifty feet in length, and in each was planted seed cane containing 200 to 250 good eyes. Five plats were planted with the inoculated cane of each variety and five with cane not inoculated. The results of tests in 1935 and 1936 are included in table 5.

In judging the results given in the above table, it must be borne in mind that reduction in yield does not necessarily have to be in proportion to the reduction in germination. Some varieties may show a marked reduction in germination, yet have a sufficient number of stalks in the row at an early date due to very rapid suckering.

Of the canes grown in the tests, only two, P.O.J. 213 and C.P. 807, showed very marked reductions in yield due to inoculation of the seed pieces with the red rot disease. Of the other varieties, the ones which now comprise the larger part of the plantings in the Sugar Belt, Co. 290 and C.P. 28-19 seemed to suffer the worst in the tests, while C.P. 28-11 apparently did not suffer at all.

TABLE 5. EFFECT OF RED ROT ON GERMINATION AND YIELD OF CANE VARIETIES IN PLATS AT BATON ROUGE IN 1935 AND 1936. EACH TEST REPLICATED FIVE TIMES.

		——1935——		——1936——	
Variety	Treatment of Seed Cane	Germination Per Cent April 11	Yield Tons per Acre	Germination Per Cent May 11	Yield Tons per Acre
Co. 281 . .	Not Inoculated	20.8	32.6	25.5	35.24
	Inoculated	18.0	24.9	22.0	33.7
Co. 290 . .	Not Inoculated	38.5	59.3	44.5	54.5
	Inoculated	23.1	45.7	38.5	47.6
C.P. 28-11 .	Not Inoculated	32.0	38.7	26.0	36.72
	Inoculated	29.2	39.2	24.0	37.4
C.P. 28-19 .	Not Inoculated	27.2	35.2	25.5	33.66
	Inoculated	21.2	31.6	27.0	29.94
C.P. 29-320	Not Inoculated	17.6	37.0	30.5	38.56
	Inoculated	19.6	36.8	25.0	35.74
C.P. 807 . .	Not Inoculated	32.4	47.4		
	Inoculated	11.6	22.0		
P.O.J. 213 .	Not Inoculated	19.2	31.7		
	Inoculated	4.0	9.2		

As these tests were conducted on a well-drained, fairly sandy soil, it is assumed that the decreases from red rot were as low as would occur in any part of the Sugar Belt. Much greater losses could be expected from red rot on soils not so well drained or on black, heavy soils.

It should also be stated that a small red rot test was conducted with the new variety C.P. 29-116 in 1936. While the test was small, there was no indication that this variety will be injured to any extent by the red rot disease in the seed cane.

GENERAL CONCLUSIONS

From the results given in this article, some rather definite statements from a disease standpoint can be made regarding the varieties of cane now being grown commercially in Louisiana. It should be remembered, however, that these statements apply only to the immediate future.

The variety Co. 281 is an extremely valuable cane and is now planted on a very large scale in the State. It is the only cane that can be windrowed satisfactorily and it is very evident that every planter must have a certain portion of his crop in varieties that can be windrowed in seasons when windrowing is necessary. Unfortunately Co. 281 has some very undesirable characteristics, one of which is its extreme susceptibility to the mosaic disease. Even under good growing conditions in the main part of the Sugar Belt, annual losses of 8 to 12 per cent can be expected with this variety. Fortunately, however, there is no evidence that the losses are increasing from year to year. If the planters have been growing Co. 281 satisfactorily during the past few years—and they have been doing so—there is no apparent reason why they should not continue to do so. However, when the plant geneticist produces a good windrowing cane with other desirable characteristics, the Co. 281 cane will disappear from Louisiana as quickly as did the P.O.J. canes. Until that time comes, Co. 281 will have its place on the Louisiana plantations and yields as good as those in the past can apparently be expected.

The variety Co. 290 is injured to some extent by both mosaic and red rot but its high yielding characteristics point to its culture in certain sections of Louisiana for some time. As the mosaic spreads but slowly in this variety, attempts to control the disease by rogueing and disease-free seed plots should be made.

The three newer varieties, C.P. 28-11, C.P. 28-19 and C.P. 29-320, meet the disease standards satisfactorily. None of them is affected seriously by mosiac. C.P. 28-19 is showing slightly greater red rot losses than at first but no serious losses can be expected under field conditions except possibly occasionally on poorly drained or black, heavy soils. C.P. 29-320 may also suffer from red rot on such soils.

C.P. 29-116 is decidedly resistant, at present, to mosaic and red rot, and meets the standards set for these troubles.

II. POSSIBLE MIGRATION OF SPORES OF RED ROT FUNGUS IN CANE STALKS

R. E. Atkinson and C. W. Edgerton

It is generally assumed that the fungus causing the red rot disease of sugar cane, *Colletotrichum falcatum,* travels along or through the fibrovascular bundles in the cane stalk. Under ordinary conditions in the field the fibrovascular bundles of stalks infected with the disease take on a deep red color. The disease breaks out of these bundles in the form of red necrotic lesions, and then may spread through the softer tissues of the internode. The red bundles may often be traced through several nodes and internodes. The assumption that the fungus does travel through the bundles seems to be a well-established fact. How the fungus travels through the bundles, however, is not entirely clear.

From work carried on at the Louisiana Agricultural Experiment Station during a period of more than twenty-five years, it is known that there are two distinct types of spread of the red rot disease through a stalk. Ordinarily when a stalk of standing cane is inoculated in the field during the summer, the disease will spread from internode to internode slowly. It usually takes from two to four months for the infection to show for more than two to three internodes away from the point of inoculation. It is assumed that the spread of the disease under such circumstances is due entirely to the growth of the mycelium through the fibrovascular bundles. On the other hand, if stalks of a susceptible variety are cut at planting time in the fall and planted after being inoculated with the red rot fungus, the disease will ordinarily spread practically through the stalk in three to five days. The spread through the stalk is much faster than would be expected from the growth of the mycelium. The red rot symptoms which show in such stalks are also different from those in which the disease has developed slowly.

In the fall of 1936, some tests were conducted with results which may help to explain the observations which had previously been made. It has been demonstrated that it is possible for the spores of the red rot fungus to be carried through the bundles in the transpiration stream.

The tests were started in October. In the first test, stalks were cut and inoculated with a pure culture of the red rot fungus and then planted. Typical red rot symptoms were observed after four days. In this period red areas developed as far as 48 inches from the point of inoculation. This means that the fungus had to travel at a rate of at least one-half inch per hour. This is much faster than would be possible for the mycelium to grow. Free hand sections through the red areas showed the typical granular mycelium of the red rot fungus, and tissue cultures gave rise to *Colletotrichum falcatum.* This experiment was repeated. Red areas 3 to 4 internodes above the internode inoculated appeared after 5 days. These areas were cultured, and *C. falcatum* was isolated. The apparently healthy tissue directly below or between the red areas all gave rise to the red rot fungus, while only three out of thirty pieces from below or between red areas produced red rot mycelium. As the fungus was not commonly present in the tissues between the red areas, it seemed possible that the spores were being carried through the vessels, lodging and germinating to produce infection.

Cut stalks were again inoculated November 2 and on November 5 red areas could be seen in split stalks as high as the fourth internode. The rate of spread was calculated as one-fourth an inch per hour. Again free hand sections showed that there was mycelium in the red areas.

In order to show definitely that spores could travel in the transpiration stream, living stalks of C.P. 807 cane with top leaves attached were placed in a crock containing a spore suspension of *Colletotrichum falcatum* on November 14. The lowest node was cut off under water. By the next day all the water in the crock had been taken up by the plants or evaporated. On November 16 cultures were made from the internodes of the stalks. Five large pieces of internode tissue about one-half cubic inch in size were cut from each internode and incubated five days. From the lowest internodes and the next above, 16 out of 25 pieces gave rise to red rot mycelium, while 2 pieces out of 30 from the third and fourth internodes gave rise to the fungus. Tissue cultures were also made from two stalks of the same test on November 18. Red rot was present in 26 out of 30 of the lowest three internodes, 7 out of 20 of the fourth and fifth internodes, and was not present in 15 from the sixth and seventh internodes.

A similar experiment was set up on November 21 in which Co. 290 cane was used, and the water containing the spore suspension was not allowed to evaporate completely. Thirteen stalks with tops intact were placed upright in the spore suspension. At the same time twelve stalks were inoculated by puncture in the second internode from the bottom and kept in the laboratory. Isolations from internode tissue of three stalks from the spore suspension on November 23 showed that red rot was present in the inoculated internode and in the first, second, and third internodes above, but not in the fourth and fifth. The red rot was isolated with less frequency from the upper internodes. Cultures made from two stalks inoculated by puncture demonstrated that the organism was present in internode inoculated and the second internode above in one stalk and in interode inoculated and the second and fourth internodes in the other stalk.

That the tracheary vessels which transport water from the roots to the leaves are open for great distances was proved by drawing Higgins' American India Ink, a colloidal, non-diffusable dye, through stalks of cane with the aid of a vacuum pump. While the basal node of some varieties resisted the passage of the ink, the other nodes seemed to offer but little resistance and the ink was rapidly drawn through pieces containing three or more nodes. The nodes of C.P. 29-320 and

C.P. 29-116 offered considerably more resistance to the passage of the ink than did those of some other varieties. In no case was the ink drawn through pieces of these varieties containing more than one node.

A spore suspension of *Colletotrichum falcatum* was also drawn through cane stalks with the vacuum pump. Spores came through long stalks very readily. The spore suspension, after passing through the cane stalk, was examined and practically the same concentration of spores was found as was in it before entering the stalk.

These tests show that it is possible for spores of *Colletotrichum falcatum* to travel through the fibrovascular bundles and suggests strongly that this is what occurs when cut stalks are inoculated at planting time.

III. IMMUNITY STUDIES WITH SUGAR CANE MOSAIC

I. L. Forbes, P. J. Mills, and C. W. Edgerton

The problem of acquired immunity in plants has long held the attention of plant pathologists, but it is only recently that much consideration has been given the subject in connection with virus diseases. In the last few years, however, it has been shown that plants infected with one strain of a virus may become immune from infection with other virus strains. For example, tobacco plants affected by ordinary tobacco mosaic or by mild strains of this disease become immune to the aucuba mosaic of tomato, which is caused by a severe strain of the tobacco-mosaic virus (1).* It likewise has been shown that zinnia plants affected by ordinary cucumber mosaic or by mild strains of this disease are immune from infection by a severe strain of cucumber mosaic virus (3). Similarly, it has been found that trees having little peach disease are immune from yellows and trees having yellows are immune from little peach; the two diseases are caused by closely related viruses, or possibly by strains of the same virus (2). Other similar reports occur in the literature on virus diseases of plants.

It has been known for some time that there are a number of different mosaic viruses in sugar cane in Louisiana (4). Some of these produce symptoms which are strikingly different. Two of these strains which are known as the green mosaic and the yellow mosaic are very common in the State. It is usually easy to recognize which strain is present in a plant by the symptoms produced. Usually the stripes present on the leaves of a plant affected by the yellow virus are so deficient in chlorophyll that they are nearly white in contrast to the light green stripes characteristic of the green mosaic. Usually during the summer while the plants are growing rapidly these differences are marked. In the spring, however, or sometimes on young plants, the stripes on the plants affected with the yellow virus contain enough chlorophyll so that they resemble closely the stripes on plants affected with the green mosaic. Under such conditions, then, it is not always possible, by symptoms alone, to say which mosaic is present in a plant.

Both the yellow and green mosaic strains may occur in different plants of the same variety. Both types were observed in the variety C.P. 28-70 as early as 1932 (4). Whether these two viruses may occur together in the same plant has been uncertain, although observations over a period of years seemed to indicate that they did not.

In the summer of 1936, inoculation tests were conducted to determine whether plants showing symptoms of green mosaic are immune to the yellow mosaic, and also whether those showing symptoms of yellow mosaic are immune to the green mosaic. Plants showing the yellow mosaic symptoms were inoculated with virus from plants showing the green mosaic symptoms and plants with green mosaic were inoculated with virus from plants showing the yellow mosaic symptoms.

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* Numbers in parentheses refer to "Literature Cited," at the end of this section.

The mosaic virus was obtained by grinding plants of C.P. 28-70 showing yellow mosaic and plants showing green mosaic in separate meat grinders which had been previously sterilized in 60 per cent ethyl alcohol and then thoroughly washed in hot water. The juice or virus was obtained from the ground material by pressure and was collected in alcohol-sterilized bottles. An inoculation was made by dropping one-half c.c. or more of virus into the spindle and pricking the closely encircling leaves and leaf sheaths about 20 times with a previously sterilized fine needle in order to carry the virus into the growing tissues of the plant. Plants were about 10 to 15 inches in height when first inoculated. The inoculations were usually made within three hours after the viruses were extracted from mosaic plants.

On May 21, 1936, 128 stalks of C.P. 28-70 showing yellow mosaic were inoculated with the green virus and 150 stalks of the same variety showing green mosaic were inoculated with the yellow virus. As checks, 50 healthy stalks of C.P. 28-70 were inoculated with the green virus and 50 were inoculated with yellow mosaic virus. All of these plants were inoculated a second time with the same viruses on June 6.

Careful observations were made from time to time to determine whether or not green mosaic plants developed any symptoms of yellow mosaic as a result of inoculation with yellow mosaic virus, and, likewise, whether yellow mosaic plants contracted green mosaic as a result of artificial inoculation with virus of green mosaic. On July 7, 1936, all of the 150 green mosaic plants inoculated with yellow mosaic virus still showed green mosaic, though a few of the plants showed some doubtful yellow mosaic symptoms in new growth. Of the 128 yellow mosaic plants inoculated with green mosaic virus, all showed yellow mosaic, although a few showed doubtful green mosaic symptoms in new growth. Of the 50 healthy plants inoculated with yellow mosaic virus, 34 showed yellow mosaic, 5 had mosaic symptoms which were not as yet definite, and 11 plants were free from mosaic symptoms. In the other check, of the 50 healthy plants inoculated with virus of green mosaic, 41 showed mosaic apparently of the green type, although it was too early to say definitely whether some might not develop yellow symptoms, 8 showed no mosaic, and 1 plant was missing.

In October, 1936, the cane was planted in the field and the individual stalks staked off in such a manner that the type of mosaic developing in the plants coming from each stalk (seed piece) could be determined in the spring.

At planting time on October 15, 1936, seven of the 150 green mosaic stalks inoculated with yellow mosaic virus were missing or dead. The remaining 143 stalks were cut and planted in a 300-foot row. At the same time, twelve of the yellow mosaic plants inoculated with green mosaic virus were missing or dead. The remaining 116 stalks were planted in a 300-foot row.

The healthy stalks which had been inoculated for controls were also planted. Of the 50 healthy plants that had been inoculated with virus of green mosaic, one was missing, two showed no mosaic, five showed yellow mosaic, and forty-two showed green mosaic at planting time. Of the 50 healthy plants that had been inoculated with yellow mosaic, two were missing, six showed no mosaic, three showed green mosaic, and thirty-nine showed yellow mosaic. All stalks were planted October 13, and a stake was placed after each stalk. For comparison, there was also planted 300 linear feet of apparently healthy C.P. 28-70 on the same date.

All plants developing from the planted stalks were carefully watched during the spring of 1937. Growth conditions early in the season were not very satisfactory and consequently the symptoms characteristic of yellow mosaic did not develop satisfactorily until rather late.

On June 14, however, the mosaic symptoms had developed sufficiently so it was possible to obtain reliable readings. The readings made on that date are briefly summarized.

Check, healthy plants inoculated with green virus. All plants developing from the 42 stalks that showed green mosaic symptoms at planting time had definite green mosaic symptoms. All developing from the five stalks that showed yellow mosaic symptoms had yellow mosaic symptoms. All developing from the two healthy stalks showed no mosaic symptoms.

Check, healthy plants inoculated with yellow virus. Yellow mosaic plants were present in every stool developing from the 39 stalks that showed yellow mosaic symptoms at planting time. All plants developing from the three stalks that showed green mosaic symptoms at planting time had definite green mosaic symptoms. Plants developing from four of the stalks that were healthy at planting time showed no mosaic symptoms; plants from one showed green mosaic and plants from another showed yellow mosaic symptoms.

Check, healthy plants not inoculated. Of the large number of stools in the row planted with apparently healthy seed cane, eleven showed green mosaic, fourteen yellow mosaic, and all the others no mosaic symptoms.

Green mosaic inoculated in plants with yellow mosaic. In every stool developing from these stalks, there were some plants showing definite yellow mosaic symptoms.

Yellow mosaic inoculated in plants with green mosaic. Every plant developing from these stalks showed green mosaic symptoms.

The evidence presented in this test shows rather definitely that (1) the viruses responsible for the yellow and green symptoms are distinct; (2) that both viruses do not occur in the same plant; and (3) that a plant affected by one virus is rendered immune to the other one.

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CANE MOLASSES IN POULTRY RATIONS

By

CHARLES W. UPP

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Cane Molasses In Poultry Rations

By

CHARLES W. UPP

INTRODUCTION

As attested by the report of Dalrymple in 1906, blackstrap molasses has long been used as a feed for livestock in Louisiana. According to this bulletin, planters stated that molasses was fed to all classes of farm animals (including work stock) except poultry. Molasses is considered to be highly digestible and, in moderate amounts, equal to corn, pound for pound, in rations for the larger farm animals. No digestion trials and few feeding trials of molasses for poultry had been reported when the present work was initiated.

It might be well to differentiate between blackstrap molasses and cane sirup for those not familiar with the manufacture of these products.

Blackstrap cane molasses is the liquid residue remaining after commercial raw sugar has been extracted from cane juice. It contains sucrose, reducing sugars, minerals, water, gums, and miscellaneous acids. Cane sirup, on the other hand, is the extracted juice of sugar cane that has been concentrated by boiling, with nothing removed.

Molasses is being used more extensively each year in poultry rations made by commercial feed manufacturers. The results reported herein substantiate previous work which indicates that blackstrap molasses is a suitable ingredient for poultry rations.

PREVIOUS INVESTIGATIONS

The 1927-28 Report of the Louisiana State Chemist, Kerr (1928), results from the same laboratory (1931), Dalrymple (1920), Jull (1930), and Fraps (1931) give the following analyses for cane molasses:

	Louisiana Analysis (1927)	Dalrymple (1920)	Jull (1931) Average Composition	Average of 21 Analyses Fraps (1931)	Louisiana Analysis (1931)
Dry Matter, per cent	77.6	77.8	75.5	78.6	76.4
Water, per cent	22.4	22.2	24.5	27.4	23.6
Ash, per cent	9.3	8.13	6.8	6.4	15.9
Protein, per cent	2.4	--------	3.1	3.6	2.25
Nitrogen Free Extract per cent	65.9	53.6	66.1	55.4*	58.2
Fiber, per cent	0.0	--------	0.0	--------	0.0
Fat, per cent	0.0	--------	0.0	--------	0.0

*Total sugar as invert.

It may be noted from these analyses that blackstrap molasses is free from fat and fiber, rich in carbohydrates, very low in protein, and relatively high in ash content.

Spencer (1917) states, "The composition of sugar-cane molasses is very variable, being dependent not only upon the composition of the cane but also,

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Page 4. Second line from top of page should follow line 7, paragraph 2.

and to a much greater degree, upon the process of manufacture." Spencer feed at that age and the consumption of mash and grain is not given sepa- gives the approximate composition of third molasses, summarized from analysis made at the Louisiana Station, as follows:

Water	20.00	Nitrogenous bodies (total N-0.5%)	3.00
Ash	8.00	Soluble gums	2.00
Sugars	62.00	Free Acids	2.00
		Combined Acids	3.00

MOLASSES IN CHICK RATIONS

Winter (1929), on the basis of four trials, found that molasses improved milkless rations for growing chicks and concludes that cereal grains may be replaced by molasses, pound for pound, up to 10 per cent in growing rations. One trial indicated that 15 per cent molasses was of no value in preventing coccidiosis. Bice (1933) fed molasses as 5, 7, and 10 per cent of the mash ration. The actual consumption of molasses after the chicks were 10 days of age cannot be determined from his report, since the chicks were given grain rately. This worker concluded that molasses fed in amounts not exceeding 7 per cent of the **mash** was satisfactory for growing chicks. Molasses did not prevent coccidiosis.

Maw (1933), basing his conclusion on the results of only one trial, states, "The addition of molasses to the mash fed to chicks in batteries caused an increase in feed consumption without a corresponding increase in body weight." A maximum of 7 per cent molasses was fed. Growth was quite uniform for all lots. Mortality was higher in the lots fed 3, 5, and 7 per cent molasses. The general indication of these previous investigations is that molasses may be used in chick rations with good results.

MOLASSES IN LAYING RATIONS

Winter (loc. cit.) noted in two laying trials that molasses made the ration laxative and that more than 10 per cent in an all-mash laying ration was undesirable. He states, "Molasses appeared to have little or no influence on feed consumption, body weight, or production, but did have a tendency to lower mortality and contribute toward better health and condition of birds."

Bethke and Record (1932) note that cane molasses failed to improve hatchability. Maw (loc. cit.) obtained lower egg production with molasses rations, with no apparent effect on feed consumption or body weight. Only one trial was conducted over a period of twenty weeks with 20 birds per lot.

In a preliminary trial at this station (Upp, 1931), two pens of Leghorn hens were fed for eight months a ration containing 10 per cent molasses. The results were, in general, satisfactory but suggested two problems to be considered in feeding molasses: (1), to maintain clean litter, a problem caused by increased moisture content of the droppings, and (2) to control flies in molasses fed pens, since molasses feeds tend to attract flies.

These earlier results indicate that molasses may be a suitable ingredient for laying rations if properly used.

MOLASSES IN FATTENING OR FINISHING RATIONS

Graham (1906) used molasses in fattening rations and concluded it was not economical under his conditions. The cost of molasses as given in his report was, however, about ten times as high as current prices in Louisiana. This worker states, "Molasses also appeared to induce feather pulling." The rates of gain were about equal for rations with and without molasses.

Hartwell and Kirkpatrick (1911) added sugar to fattening rations, but this did not result in increased gains or increased palatability.

Lee (1911) reports that molasses was fed to color the skin of market birds and that a deep-yellow product resulted.

Lippincott (1927), reporting on unpublished data from the Iowa station, states, "When enough molasses was added to a basal ration of oat flour to form 10 per cent of the solid portion of a milk-fattening ration, it increased the average gains slightly, though a little less feed was consumed. It did not appear to increase the palatability of the ration. The flavor of the fowls fattened on molasses was excellent." Winter (loc. cit.) obtained slightly better gains with slightly increased feed consumption using rations containing up to 10 per cent cane molasses, as compared to non-molasses rations. Bice (loc. cit.) concludes that "Use of fattening rations containing 5, 10, and 15 per cent, respectively, of molasses resulted in economical gains with broilers, but in inefficient production (i.e. gains) with hens in fattening batteries." Ferber and Chodziesner (1933) used molasses successfully in fattening rations for geese.

These trials suggest that molasses is a desirable ingredient for finishing rations.

MATERIALS AND METHODS

These experiments started October 1, 1932, and were completed May 31, 1935. The tests with laying hens extended over a period of ten months in each of the first two years and for eight months the third year. Two tests on finishing broilers were conducted in the spring of 1934 and one ten-day trial with hens was carried on the same year. Another test with broilers was conducted in 1935. Chick experiments were conducted during the springs of 1933, 1934, and 1935.

EXPERIMENTS WITH LAYING HENS

Thirty S. C. W. Leghorn pullets were used in each lot the first year, twenty-five per lot the second year, and twenty-four per lot the third year. Sisters and half-sisters were distributed in the several lots to overcome to some extent the bias that might result from breeding. The birds were trapnested throughout the tests and only those eggs laid in the trapnests were counted. The lots were housed in similar sections (12′x18′) of a laying house. Double yards were accessible to each lot, with a green feed crop available in the yard in use. The green feeds grown and used from October to May were Italian rye grass and white Dutch clover. Soybeans and Sudan grass, replanted at intervals of 3 to 4 weeks, were used as summer green feeds.

No artificial lighting was used in 1932-33, but morning lights were used from October through March the two following years.

All eggs laid during the first five days of January, February, March, and April were weighed individually in grams on special Toledo egg scales. Average egg weight was determined for each hen for the season. Egg size for the lot was calculated, the egg size of the hen rather than a direct average of all eggs from a lot being used as a basis. The birds were weighed individually on the first of each month and average body weight per lot determined on that basis.

An adequate sample of eggs from each lot was set and fertility and hatchability results recorded. Post mortem examinations were made to check up on deaths attributable to nutritional disturbances.

The all-mash laying rations used are given in Part 1 of Table 1. Analyses of these rations are given in Part 2, Table 1.

CHICK EXPERIMENTS

Seven series of chick experiments, with 5 lots per series, were conducted for eight-week periods. Three series were run in 1933, two in 1934, and two in 1935. Twenty-five pedigreed S. C. W. Leghorn chicks were used in each lot. The chicks of each hen were distributed to the different lots in rotation. This probably increased the variation in growth rate within the lot but tended to minimize the effects of any inherent difference in growth (between lots). All chicks were brooded in electrically heated battery brooders for four weeks then transferred to unheated battery brooders for the second four weeks of the experiments.

The first series of chicks in 1933 were given only limited amounts of feed, but all other series received all-mash rations ad libitum. In the two series of 1935 the original lot 5 ration was replaced by one containing 5 per cent dried molasses (Molaska), as noted in Table 2. Part 1 of Table 2 gives the all-mash chick rations; analyses are given in Part 2 of the same table.

TABLE 1—PART 1

ALL-MASH LAYING RATIONS

Ingredients	Lot 1 Basal Ration	Lot 2 —5 Yel. C. M. +5 Molasses	Lot 3 —7.5 Yel. C. M. +7.5 Molasses	Lot 4 —10 Yel. C. M. +10 Molasses	Lot 5*
Yellow Corn Meal	50	45	42.5	40	45
Rice Bran	12	12	12	12	12
Rice Polish	12	12	12	12	12
Meat Scrap (50% Pro.)	15	15	15	15	15
Dried Buttermilk	5	5	5	5	5
Alfalfa Leaf Meal	3	3	3	3	3
Mineral Mixture	3	3	3	3	3
Blackstrap Molasses	—	5	7.5	10	—
Dried Molasses	----	----	----	----	5
	100	100	100	100	100

Laying ration mineral mixture: 6 parts pulverized oyster shell
3 parts bone meal
1 part salt.

Oyster shell and grit as well as clean water were available ad libitum.
*Lot 5, dried molasses (Molaska) used only in 1934-35.

TABLE 1—PART 2

ANALYSES OF LAYING RATIONS

Lot 1

Protein	16.75
Fat	5.80
N. F. E.	51.60
Fiber	2.95
Moisture	11.95
Ash	10.95

Lot 2

Protein	16.69
Fat	5.50
N. F. E.	52.11
Fiber	3.20
Moisture	11.90
Ash	10.60

Lot 3

Protein	16.50
Fat	5.65
N. F. E.	51.80
Fiber	2.90
Moisture	11.55
Ash	11.60

Lot 4

Protein	17.38
Fat	5.60
N. F. E.	52.12
Fiber	2.80
Moisture	10.40
Ash	11.70

Lot 5

Protein	16.81
Fat	5.70
N. F. E.	51.69
Fiber	2.90
Moisture	11.70
Ash	11.20

TABLE 2—PART 1

ALL-MASH CHICK RATIONS

INGREDIENTS:	Lot 1 Basal Ration	Lot 2 —5 Corn Meal +5 Molasses	Lot 3 —10 Corn Meal +10 Molasses	Lot 4 —15 Corn Meal +15 Molasses	Lot 5 (1933, 1934) —10 Rice Bran +10 Molasses	Lot 5 (1935) —5 Corn Meal +5 Dried Molasses
Wheat Bran	13	13	13	13	13	13
Yellow Corn Meal	40	35	30	25	40	36.75
Meat Scrap	10	10	10	10	10	10
Rice Bran	10	10	10	10	----	10
*Cottonseed Meal	10	10	10	10	10	10
Dried Buttermilk	10	10	10	10	10	10
Pulverized Oyster Shell	4.2	4.2	4.2	4.2	4.2	4.2
Salt	.8	.8	.8	.8	.8	.8
**Cod Liver Oil	2.0	2.0	2.0	2.0	2.0	.25**
Blackstrap Molasses	----	5	10	15	10	----
Dried Molasses (Molaska)	----	----	----	----	----	5
Total	100	100	100	100	100	100

Note: No other feed except fresh water was available.

*Corn gluten meal was used in 1933 instead of cottonseed meal. The latter was substituted because it is more commonly available in this region.

**Twenty-five hundredths per cent concentrated cod liver oil was used in all lots in 1935 instead of 2 per cent regular oil that had been used previously. The difference was made up of corn meal.

TABLE 2—PART 2

ANALYSES OF CHICK RATIONS

Lot 1

Crude Protein	18.94
Fat	7.15
Nitrogen Free Extract	47.36
Crude Fibre	5.20
Water	9.75
Ash	11.60

Lot 2

Crude Protein	18.81
Fat	7.10
Nitrogen Free Extract	48.44
Crude Fibre	5.00
Water	10.65
Ash	10.00

Lot 3

Crude Protein	18.88
Fat	7.00
Nitrogen Free Extract	46.32
Crude Fibre	5.00
Water	10.50
Ash	12.30

Lot 4

Crude Protein	18.94
Fat	6.95
Nitrogen Free Extract	44.66
Crude Fibre	5.30
Water	11.50
Ash	12.65

Lot 5

Crude Protein	19.19
Fat	6.00
Nitrogen Free Extract	49.31
Crude Fibre	3.85
Water	11.00
Ash	10.65

FATTENING OR FINISHING MARKET BIRDS

Two "fattening" tests in 1934 and one in 1935 were conducted with eight-week-old S. C. W. Leghorn cockerels. In each test three lots of twenty birds each were given finishing rations for a two-week period. The cockerels had been battery grown on all-mash rations prior to the time they were placed in the fattening batteries. The fattening rations were fed three time daily as wet mash, of a consistency similar to pancake batter. The birds did not at first relish the watery feed but soon learned to eat it. In 1934, one eleven-day test was made with R. I. Red hens. The hens were purchased from a farmer as healthy yard-run birds of fairly good breeding. These birds received the same ration fed the cockerels. Dressed and drawn weights were obtained when the hens were killed and dressed for market. Palatability tests were made of broilers that had been fed the different rations.

The birds were weighed individually preceding the test, at the end of one week, and at the end of the test. All weights were taken after feed had been withheld for 12 hours. Separate lot records of feed consumption were kept for each week. Only water was given in addition to the rations designated in Part 1 of Table 3. Analyses of the rations are given in Part 2 of Table 3.

TABLE 3—PART 1

FINISHING RATIONS

Ingredients:	Lot 1 Basal Ration	Lot 2 +10% Molasses —10% Yel. Corn Meal	Lot 3 +15% Molasses —15% Yel. Corn Meal
Yellow Corn Meal	50	40	35
Rice Polish	35	35	35
Dried Buttermilk	8	8	8
*Cottonseed Meal	7	7	7
Blackstrap Molasses	----	10	15
Total	100	100	100

Note: *In 1935 no cottonseed meal was used and dried buttermilk was increased 15 per cent.

TABLE 3—PART 2

ANALYSES OF FINISHING RATIONS

Lot 1

Crude Protein	15.19
Fat	6.60
Nitrogen Free Extract	61.31
Crude Fibre	2.40
Water	10.50
Ash	4.00

Lot 2

Crude Protein	15.13
Fat	6.20
Nitrogen Free Extract	60.27
Crude Fibre	2.80
Water	11.05
Ash	4.55

Lot 3

Crude Protein	14.00
Fat	5.95
Nitrogen Free Extract	61.15
Crude Fibre	2.70
Water	11.10
Ash	5.10

Data and Discussion

RESULTS WITH LAYING HENS

The results with laying hens are summarized in Table 4. Egg production, feed consumption, egg size, hatching results and mortality are considered in this table.

Feed Consumption: No consistent differences in feed consumption per bird, or per dozen eggs produced, were associated with the several diets. Molasses in the ration apparently did not increase feed consumption appreciably. It was noted as a general observation, supported by short time tests, that the molasses rations caused an increased consumption of water.

Egg Production and Mortality: In three cases average egg production was slightly lower in lots fed rations containing molasses than in those without it, while production of seven molasses fed lots equaled or exceeded

TABLE 4

SUMMARY OF RESULTS WITH LAYING HENS

Lot No.	No. in Lot	Per cent Molasses in Ration*	Average Feed Consumed		Eggs Produced Per Bird**	Size of Eggs in Grams	HATCHING RECORD			Per Cent Mortality of Hens (a)
			Per Bird	Per Doz. Eggs			No. Eggs Set	Per Cent Fert.	Per Cent Hatch of Fert. Eggs	
			YEAR OF 1932-33. (TEN MONTHS—OCTOBER 1 TO JULY 31)							
1	29	0.0	77.2b	6.9	135.0	55.1	458	86.2	74.4	14.8
2	31	5.0	66.4	5.7	140.9	55.8	484	71.9d	77.9	20.7
3	28	7.5	82.2b	9.3	131.7	56.7	407	93.4	81.8	21.4
4	29	10.0	68.5	6.4	139.3	54.5	367	82.8	78.6	23.3
			YEAR OF 1933-34. (TEN MONTHS—OCTOBER 1 TO JULY 31)							
1	25	0.0	65.6	6.2	138.0	57.7	209	88.0	88.0	20.8
2	25	5.0	67.6	6.5	134.8	56.4	202	90.6	88.5	28.0
3	25	7.5	67.5	5.8	145.1	55.4	197	78.2	79.9	29.2
4	25	10.0	69.0	5.9	145.3	53.4	221	88.7	90.8	25.0
			YEAR OF 1934-35. (EIGHT MONTHS—OCTOBER 1 TO MAY 31)							
1	24	0.0	56.4	5.5	129.3	57.8	233	45.9	69.8	16.7
2	24	5.0	51.7	4.7	141.3	55.7	238	85.7	74.0	13.0
3	24	7.5	52.2	5.4	128.7	56.5	234	52.1	78.7	13.6
4	24	10.0	54.7	6.2	118.7	55.0	238	86.6	74.8	25.0
5	24	5.0c	52.6	4.8	142.2	55.5	249	53.8	88.1	13.6

*Blackstrap molasses replaced yellow corn meal, pound for pound, in all-mash rations.

**Calculated on a ten-day basis.

a. Accidental deaths not included.

b. These figures should be discounted because rats consumed appreciable amounts of feed.

c. Dried molasses (Molaska). On a dry matter basis, equivalent to about 7.5 per cent blackstrap molasses.

d. Only one male was in this lot for most of the season, whereas two males were used in the other lots.

that of the check lots. The largest differences were in favor of two rations fed in 1934-35, containing 5 per cent blackstrap and 5 per cent dried molasses, respectively, as compared to the basal ration for that year. In these cases the molasses lots produced an average of approximately one dozen eggs per bird more than the check lot. Consideration of egg production by months revealed that seasonal variations in rate of production were quite similar for all lots.

The lots given rations containing 10 per cent molasses (of the total ration) yielded as well as any other lot in two of the three years. It was evident, however, that this amount of molasses was a maximum, if not an excess, that it is advisable to use in laying rations. All-mash rations containing 10 per cent molasses were decidedly laxative, particularly for certain birds. The litter in these pens became damp and sticky soon after being placed in the house and the droppings were quite watery at all times. Such a laxative diet, however, did not markedly impair the health or laying ability of the hens. Mortality was somewhat higher in the molasses fed lots in 7 of 10 cases, but did not increase as the amount of molasses in the ration was increased. It is doubtful that molasses was the determining factor in the higher mortality.

Egg size was not noticeably influenced by the variations in the rations. The smallest egg size each year occurred in the 10 per cent molasses lots but most differences were relatively small and were not consistent.

Hatching Record: In only one instance was hatchability lower in a molasses fed lot than in its respective check lot. Hatchability was quite uniform for all lots for any given year. Molasses certainly did not injure the hatching quality of the eggs, but if the hatching quality was increased the improvement was slight. In the one test in which dried molasses was used hatchability was increased considerably; however, further tests will be necessary before a definite conclusion is reached.

TABLE 5

AVERAGE BODY WEIGHT—BY MONTHS

(WEIGHTS IN GRAMS)

Lot	Per cent Molasses in Ration	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Av. for exp. Year
						1932-33							
1	0	1358	1529	1570	1650	1777	1708	1599	1598	1562	1476	1516	1577
2	5	1380	1563	1639	1665	1784	1767	1688	1647	1656	1468	1519	1616
3	7.5	1496	1598	1722	1790	1940	1918	1822	1774	1792	1670	1574	1736
4	10	1336	1509	1636	1635	1757	1738	1642	1670	1624	1517	1477	1594
						1933-34							
1	0	1348	1590	1562	1624	1680	1684	1640	1646	1676	1592	1548	1599
2	5	1284	1551	1600	1688	1686	1718	1586	1566	1630	1502	1445	1586
3	7.5	1368	1482	1477	1486	1648	1675	1650	1656	1658	1612	1531	1621
4	10	1393	1584	1590	1741	1709	1703	1687	1704	1757	1560	1578	1656
						1934-35							
1	0	1563	1670	1692	1730	1634	1662	1665	1762	1754	--------	--------	1681
2	5	1516	1589	1657	1694	1636	1581	1634	1664	1550	--------	--------	1614
3	7.5	1598	1656	1710	1744	1723	1656	1699	1715	1573	--------	--------	1675
4	10	1591	1617	1773	1789	1713	1657	1708	1827	1719	--------	--------	1699
5	5*	1512	1587	1616	1654	1594	1567	1608	1669	1637	--------	--------	1595

*Dried molasses.

Fertility fluctuated widely from lot to lot and from year to year, but the variations are not attributed to differences in the rations. In 1932-33 two males were used in each lot while in the two following seasons only one male was used in each lot. The males were not rotated from lot to lot. Individuality of the males was probably the chief cause of variation in fertility.

Body Weight: The average monthly body weights of hens in the different groups are given in Table 5.

These figures are of interest for several reasons. They show that the birds used were of fairly good weight for the breed. They average 3.5 to 3.75 pounds for the year and the various lots attained a maximum weight of 3.75 to 4.25 pounds. During the first two years the maximum weight was reached in March. All lots during the third year showed two peaks of increased weight, the first occurring in January and the second in May. For the two years during which the experiments continued for ten months, there was a distinct drop in weight in July and August. This tendency to lose weight during the summer and early fall has been noted in all records of pullets made at this station during the past seven years, regardless of the method of feeding or the ration fed. Method of feeding and ration influence the extent of decrease in weight but the downward trend is always noted. The cause is not known definitely but the decline may be due to climatic conditions. Other workers have noted a slight decrease in body weight in the fall of the pullet laying year, (Heuser and Andrews, 1932, and Atwood and Clark, 1930), but the decrease is not so great and it occurs much later than noted under Louisiana conditions.

TABLE 6

MOLASSES FOR CHICKS—AVERAGE WEIGHTS, 1933

WEIGHT IN GRAMS

Lot No.	Per cent Molasses	AGE IN WEEKS									Std. Dev. of Mean at 8 Weeks	
		Day Old	1	2	3	4	5	6	7	8		
		PART I—SERIES I—1933										
		ON LIMITED RATIONS (70% BASIS) HATCHED NOV. 28, 1932										
1	0	35.4	45.1	67.6	106.2	152.1	194.1	252.6	307.5	366.7	16.8	
2	5	34.5	44.3	68.3	99.1	147.8	191.6	243.8	309.2	364.0	12.0	
3	10	35.6	44.1	64.1	90.4	136.3	174.4	229.4	277.6	337.3	10.7	
4	15	34.9	42.9	62.9	87.0	131.4	169.0	219.9	252.6	300.6	9.3	
5	10*	35.2	43.8	62.3	87.9	130.9	167.7	220.6	283.0	309.0	13.1	
		PART 2—SERIES II—1933										
		FED AD LIBITUM—HATCHED JAN. 1, 1933										
1	0	35.4	45.7	63.7	89.4	114.1	179.8	244.5	335.5	462.2	20.8	
2	5	34.5	47.0	65.1	96.8	130.1	160.1	230.4	311.1	426.8	16.2	
3	10	35.6	48.1	65.7	101.2	130.0	179.4	241.3	319.4	440.6	20.9	
4	15	34.7	45.5	60.4	92.2	124.7	173.8	230.0	307.0	419.2	20.4	
5	10*	34.1	45.7	60.3	84.5	116.2	167.7	222.7	294.5	407.6	21.6	
		PART 3—SERIES III—1933										
		FED AD LIBITUM—HATCHED FEB. 2, 1933										
1	0	38.0	51.5	68.6	104.4	147.0	201.1	275.6	344.1	445.1	17.6	13.3†
2	5	38.1	51.9	65.3	107.4	155.8	207.8	265.3	329.6	403.4	16.0	8.8
3	10	37.9	51.1	68.3	112.2	158.8	221.1	277.4	346.1	422.0	14.9	12.6
4	15	38.7	51.5	65.7	100.7	133.8	183.9	241.9	312.3	372.1	25.6	17.4
5	5**	39.0	50.3	70.6	99.0	138.1	188.1	231.7	291.8	373.1	20.0	15.0

*Molasses replacing rice bran.
**Dried molasses.
†This column represents Series II and III combined.

No ration produced a consistent advantage in body weight although it was noted that the molasses fed birds tended to average heavier for the year than the check lot birds. In every case, however, the lots receiving molasses showed a somewhat greater decline from maximum weight toward the end of the year.

RESULTS WITH CHICKS

In Table 6 the average weight of chicks by weeks and the standard deviation of the mean of eight-week weights, are given for three series of chicks hatched in 1933. Table 7 gives similar data for chicks hatched in 1934 and Table 8 for those hatched in 1935. The amount of molasses replacing yellow corn meal in the several all-mash rations of all series was as follows: Lot 1, none; Lot 2, five per cent; Lot 3, ten per cent; and Lot 4, fifteen per cent. Lot 5 chicks received ten per cent molasses substituted for ten per cent rice bran during 1933 and 1934. In 1935 five per cent dried molasses (Molaska) replaced five per cent yellow corn meal in Lot 5.

TABLE 7

MOLASSES FOR CHICKS—AVERAGE WEIGHTS, 1934

WEIGHT IN GRAMS

Lot No.	AGE IN WEEKS									Std. Dev. of Mean at 8 Weeks
	Day Old	1	2	3	4	5	6	7	8	
PART 1—SERIES I—1934 FED AD LIBITUM—HATCHED FEB. 20, 1934										
1	35.8	44.5	76.0	128.0	202.7	266.1	375.6	490.0	590.0	22.8
2	36.2	45.75	74.11	117.7	175.7	240.3	328.1	439.9	519.5	18.6
3	35.8	44.24	70.3	120.6	182.35	244.7	334.4	453.8	514.0	25.9
4	35.8	44.8	73.7	134.0	182.15	256.9	341.7	458.9	535.6	20.2
5	36.5	44.3	66.3	112.54	175.6	238.1	318.7	429.1	498.2	13.4
PART 2—SERIES II—1934 FED AD LIBITUM—HATCHED MARCH 20, 1934										
1	38.2	44.7	61.9	102.0	156.09	205.7	299.13	370.43	445.6	20.0
2	37.2	37.45	54.7	93.3	143.8	202.6	303.5	378.2	450.6	18.1
3	38.0	46.04	63.6	105.74	154.35	224.5	321.82	410.0	477.1	17.9
4	37.7	44.9	60.37	93.53	140.6	218.3	302.9	392.9	458.2	24.9
5	36.7	45.67	69.6	115.17	157.9	237.6	323.5	406.96	469.6	14.1

The significance of the differences in weight was determined by "t" tests in all cases. In the first series of the 1933 tests the chicks were on limited rations; that is, instead of being allowed unlimited access to the feed, they were fed a definite amount per chick, varied according to age. This system was not used after the initial trial because while it might possibly measure more accurately the efficiency of the rations it would not give results as to the relative gains of chicks on full feed and the latter is the information sought by poultrymen. A ration might be efficient (physiologically) and yet be undesirable for use by the practical poultryman. Such would be the case if, for example, it were unpalatable and therefore not consumed in quantities sufficient to produce rapid gains. The rate of gain was necessarily retarded by the limited feeding of series I. Chicks in Lots 1 and 2 made significantly greater gains than those in Lots 4 and 5. In series II of 1933 no significant differences occurred with the different rations and in

Page 15. Table 8; figures for lot 3, part 1, 8 weeks, should be 526.7.

series III lot I chicks appeared slightly heavier (P. of less than .05 but greater than .01) than Lot 4 and Lot 5 chicks. Since no real differences existed between chicks on the same ration of series II and series III, these two series were combined and the differences in weight tested for the larger groups. These tests revealed that for the combined series, Lot 1 chicks were definitely heavier than Lot 4 or Lot 5 chicks, and probably heavier than those of Lot 2. The tests suggested that Lot 3 chicks were probably larger than those in Lot 5. It may be noted, then, that Lot 4 (15 per cent molasses) and Lot 5 chicks (10 per cent molasses replacing 10 per cent rice bran) were consistently smaller than chicks of other check lots.

TABLE 8

MOLASSES FOR CHICKS—AVERAGE WEIGHTS, 1935

Lot No.	Day Old	AGE IN WEEKS 1	2	3	4	5	6	7	8	Std. Dev. of Mean at 8 Weeks	
PART 1—SERIES I—HATCHED MARCH 19, 1935 FED AD LIBITUM											
1	36.7	50.0	85.2	127.6	183.5	253.7	334.6	445.8	527.5	13.2	
2	35.9	46.8	83.2	131.0	187.4	261.6	358.1	460.0	542.9	17.4	
3	36.7	51.8	87.8	135.5	202.6	273.0	344.1	456.7	256.7	12.8	
4	36.4	45.1	68.9	111.5	171.0	243.4	325.6	431.4	501.0	13.6	
5	36.0	36.9	56.0	90.7	138.2	206.2	284.9	384.4	437.8	21.2	
PART 2—SERIES II—HATCHED APRIL 2, 1935 FED AD LIBITUM											
1	37.1	25.1	82.4	135.2	197.2	267.4	361.6	436.8	533.2	12.4	9.0*
2	36.7	48.8	81.9	136.7	208.7	283.4	377.0	462.1	521.1	20.1	13.1
3	37.1	51.6	82.9	140.8	206.6	280.8	381.7	432.2	495.7	10.5	8.5
4	36.8	50.9	77.2	127.8	190.2	261.7	341.7	396.7	465.2	12.1	9.4
5	37.2	49.7	75.9	123.8	193.3	277.9	371.6	413.3	477.8	21.4	16.3
Std. Dev. of Mean Avge. All Lots	.67	1.14	2.25	3.81	5.73	7.93	10.91	14.22	17.34		

* This column represents Series I and II combined.

In series I, 1934, the check ration produced definitely greater gains than the ration from which rice bran was omitted (Lot 5) and probably greater gains than 5 per cent and 10 per cent molasses rations. No notable differences appeared in series II of this year. Series I and II could not be combined since all lots of series I were appreciably heavier (three cases definitely so) than the corresponding lots of series II. This tendency is in agreement with previous results at this station and with the general experience of poultrymen in the South; that is, later hatched chicks do not grow as rapidly as those hatched earlier. Gains were greater for all lots in 1934 than for the previous year.

In series I of 1935, Lot 5 chicks (5 per cent dried molasses) were significantly smaller than those of the other lots. This lot was severely chilled, which may have affected the growth rate. The weights in Lot 5, series II, were considerably lower than those of Lots 1, 2, and 3 of the same series. Lot 4 chicks made poor gains in series II. Since no real differences existed between lots fed alike, the the two series were combined. Lots 1 and 2 averaged definitely heavier than Lots 4 and 5 and Lot 3 chicks were also probably heavier than these two lots. These results indicate that an all-mash ration containing 10 per cent blackstrap molasses replacing a like amount of rice bran is definitely inferior to a similar ration containing no molasses.

It is also clear that an all-mash ration containing 15 per cent blackstrap molasses replacing yellow corn meal, pound for pound, will not produce as rapid growth as a similar ration containing no molasses. Growth was in general more uneven in the 15 per cent molasses lots, as indicated by the size of the standard deviations. In four of seven trials, growth rate in Lot 2 (5 per cent molasses) was practically as rapid as or more rapid than it was in the check lot. (See Tables 9, 10, and 11). In the three other trials growth rate of the check lot exceeded Lot 2 by about ten per cent, although in no case was it significantly greater. Lots in which 10 per cent molasses replaced yellow corn meal made slightly slower growth (average about 4 per cent) than the check lot, but in no case was the difference definitely significant. We may conclude, then, that rations in which yellow corn meal is replaced by blackstrap molasses at a 5 per cent or a 10 per cent level will produce practically as good growth as a similar ration which contains no molasses. This is further demonstrated when the feed efficiency or units of feed per unit of gain is considered. (Tables 9, 10, 11, and 12). No consistent difference in efficiency of feed existed between Lots 1, 2, and 3, but more feed was required to produce a unit of gain in Lots 4 and 5.

TABLE 9

MORTALITY, INCIDENCE OF PEROSIS, COMPARATIVE WEIGHTS, AND FEED EFFICIENCY

1933 HATCHES

Lot No.	Per Cent Molasses	Number in Lot	Per Cent Mortality	Per Cent Perosis	Aver. Wt. % as Compared to Check Lot	Grams Feed Per Gram Gain
SERIES I*—HATCHED NOV. 28, 1932						
1	0	25	8	0.0	------	3.12
2	5	25	16	0.0	99.3	3.36
3	10	25	0	0.0	92.0	3.42
4	15	25	8	0.0	82.0	3.97
5	10**	25	0	0.0	84.3	3.80
SERIES II—HATCHED JAN. 9, 1933						
1	0	25	24	0.0	------	3.43
2	5	25	12	0.0	92.3	3.65
3	10	25	4	0.0	95.3	3.35
4	15	25	8	0.0	90.7	3.67
5	10**	25	24	24.0	88.2	4.05
SERIES III—HATCHED FEB. 7, 1933						
1	0	25	4	4.0	------	3.53
2	5	25	0	0.0	88.6	3.79
3	10	25	0	4.0	94.8	3.76
4	15	25	4	0.0	83.6	4.33
5	10**	25	12	16.0	83.8	4.38

* Series I fed on limited ration basis.

** Molasses replaced rice bran in this case. Yellow corn meal was replaced in other lots.

As shown in Tables 9, 10, and 11, no great difference in mortality of chicks occurred in the several lots although it tended to be higher in the lots fed rations higher in molasses content (Lots 4 and 5).

The incidence of perosis is of interest. The only series in which perosis occurred in all lots was series I, 1934. Fifty per cent of the chicks of Lot 5 had perosis, while only 6 per cent of the check lot chicks were affected. Why the chicks of this series were affected more than any others is not known. Perosis occurred consistently in the lots in which rice bran was omitted. This ration produced perosis in four of five (for 80 per cent) of the trials in which it was used, with 20 per cent of all chicks affected, whereas all other rations produced perosis in only 22 per cent of the possible cases, with 3.3 per cent of the chicks affected. Only 1.7 per cent of the chicks fed the check ration (Lot 1) showed signs of perosis.

The amount of feed consumed per chick by weeks is given in Part 1 of Table 12. Lot 5 in the 1934 trials consumed less feed than the other lots and in 1935 these lots consumed more feed than the others. Lots 2, 3, and 4 show quite uniform feed consumption week by week. As noted in Part 2 of Table 12, the amount of feed required to produce a unit of gain increased consistently with the age of the chicks. In the same year the later hatched chicks required more feed per unit of gain (Part 3, Table 12).

TABLE 10
MORTALITY, INCIDENCE OF PEROSIS, COMPARATIVE WEIGHTS, AND FEED EFFICIENCY
1934 HATCHES

Lot No.	Per Cent Molasses in Ration	Number in Lot*	Per Cent Mortality	Per Cent Perosis	Aver. Weight % as Compared to Check Lot	Grams Feed Per Gram Gain
		SERIES I—HATCHED FEB. 20				
1	0	17	11.8	5.9	------	3.34
2	5	21	9.5	19.0	88.0	3.20
3	10	18	16.7	16.6	87.1	3.18
4	15	19	5.2	21.0	90.8	3.28
5	10**	12	8.4	50.0	84.4	3.58
		SERIES II—HATCHED MARCH 20				
1	0	25	4.0	0.0	------	3.45
2	5	25	12.0	16.0	101.0	3.56
3	10	25	12.0	0.0	107.7	3.49
4	15	25	16.0	0.0	102.9	3.84
5	10**	25	4.0	24.0	105.4	3.31

* Series I chicks were chilled during the first week, and mortality occurring during the first ten days is not included. This accident accounts for the small number of chicks per lot.
** Molasses replaced rice bran in this case. Yellow corn meal was replaced in other lots.

TABLE 11
MORTALITY, INCIDENCE OF PEROSIS, COMPARATIVE WEIGHTS, AND FEED EFFICIENCY
1935 HATCHES

Lot No.	Per Cent Molasses in Ration	Number in Lot	Per Cent Mortality	Per Cent Perosis	Aver. Wt. at 8 Weeks—% as Compared to Check Lot	Grams Feed Per Gram Gain
		SERIES I—HATCHED MARCH 19				
1	0	25	0.0	0.0	--------	4.10
2	5	25	0.0	0.0	102.9	3.91
3	10	25	4.0	0.0	99.8	3.72
4	15	25	16.0	0.0	95.0	4.72
5	5**	25	------*	0.0	83.0	4.05
		SERIES II—HATCHED APRIL 2				
1	0	25	4.0	0.0	--------	3.33
2	5	25	0.0	0.0	97.7	3.99
3	10	25	0.0	0.0	93.0	3.52
4	15	25	4.0	4.0	87.3	4.13
5	5**	25	16.0	0.0	89.6	5.31

* This lot was severely chilled and 56 per cent of the chicks died within 2 days. This mortality was not attributed, of course, to the diet.
** Molaska.

TABLE 12

AVERAGE FEED CONSUMPTION AND FEED EFFICIENCY

PART 1—CONSUMPTION BY WEEKS

Trials Averaged		Lot No.	Feed Consumed per Chick for Week								Total for 8 Weeks
No.	Year		1	2	3	4	5	6	7	8	
4	1934 & 35	1	29.6	67.4	117.0	182.4	248.5	291.0	341.5	379.6	
4	1934 & 35	2	25.3	62.2	124.4	191.3	254.5	306.4	356.4	396.1	
4	1934 & 35	3	30.2	75.6	132.2	196.8	241.9	298.6	346.8	372.9	
4	1934 & 35	4	27.7	63.3	125.0	182.4	263.1	305.7	350.6	407.8	
2	1934*	5	21.1	65.2	112.2	163.4	239.6	258.8	315.3	358.6	
2	1935	5	23.6	42.8	120.8	214.2	271.8	321.9	370.4	392.8	
20 lots 1934 & 35		Grams	27.0	64.5	123.0	183.5	252.7	298.4	346.6	386.4	1682.1
		Lbs.	.06	.14	.27	.41	.56	.66	.73	.85	3.72

PART 2—FEED EFFICIENCY BY WEEKS

	1st	2nd	3rd	4th	5th	6th	7th	8th
Grams Feed per Gram of Gain—20 Lots	2.37	2.45	2.64	3.15	3.62	3.34	4.03	5.37

PART 3—FEED EFFICIENCY BY DATE CHICKS WERE HATCHED

	I	II	III	I	II	I	II
Series and Year	1933	1933	1933	1934	1934	1935	1935
Date Hatched	11-28-32	1-1-33	2-2-33	2-20	3-20	3-19	4-20
Grams of feed per Gram of Gain (5 lots)	3.53	3.63	3.96	3.32	3.53	4.10	4.06

PART 4—FEED EFFICIENCY BY RATIONS
Seven Trials Combined

Ration (or lot)	1	2	3	4	5**	5x
Grams of Feed Per Gram of Gain	3.47	3.64	3.49	3.99	3.82	4.68

* Lot 5 in 1934 and lot 5 in 1935 were fed different rations, hence are considered separately.

** Five trials were conducted in which molasses replaced rice bran at a 10 per cent level.

x Two trials were conducted in which dried molasses (Molaska) replaced yellow corn meal at a 5 per cent level.

RESULTS WITH MARKET BIRDS

The results with broilers are given in Table 13. The 1935 test is not directly comparable to the 1934 tests since the rations were changed in the 1935 trial. Cottonseed meal was replaced by additional dried buttermilk and the rations containing molasses in addition (Lots 2 and 3) were too laxative for best results. A number of birds in Lot 3 went off feed by the end of the first week. Four broilers lost weight and two others failed to gain during the second week. The gains in Lot 2 also were decreased and feed efficiency lessened by this change in the ration. Rations containing blackstrap molasses should not be high in buttermilk content.

The gains of all lots in the 1934 test were satisfactory. They ranged from 26.4 per cent (Lot 3, first trial) to 46.9 per cent (Lot 2, second trial) increase over the weights at the beginning of the trials. These results indicate that battery grown leghorn broilers will make good gains on finishing rations at least under the conditions of this experiment. Molasses is shown to be a valuable ingredient for a finishing ration for broilers.

TABLE 13

FINISHING BROILERS—S. C. WHITE LEGHORNS

Lot. No.	Comparison of Rations	No. of Birds Per Lot	Average Weight At Start of Test (Grams.)	Av. Weight At End of First Week	Av. Gain First Week	Standard Deviation of Mean of Gains	Average Wt. At End of Second Week	Av. Gain Second Week	Standard Deviation of Mean of Gains	Average Gains for Two Weeks	Grams of Feed Per Gram Gain	Per Cent Gain of Original Wt.
1934—TRIAL ONE—TWO WEEKS—APRIL 17 THROUGH APRIL 30												
1	Check Lot	20	590.0	679.0	89	10.65	779.0	100.0	3.53	189.0	5.28	32.03
2	10% Molasses	20	621.5	686.0	59.5	8.96	794.0	108.0	5.88	167.5	5.95	26.95
3	15% Molasses	19	592.1	641.1	48.9	9.91	748.4	107.4	4.36	156.3	6.36	26.40
1934—TRIAL TWO—TWO WEEKS—MAY 15 THROUGH MAY 29												
1	Check Lot	19	536.8	626.3	89.5	14.04	753.7	127.4	8.12	216.8	4.62	40.39
2	10% Molasses	18	512.2	611.1	98.9	5.48	752.2	141.1	8.95	240.0	3.88	46.85
3	15% Molasses	18	492.2	565.6	73.3	9.05	698.9	133.3	8.17	206.7	4.87	41.99
1935 TRIAL—TWO WEEKS—APRIL 16 THROUGH APRIL 30*												
1	Check Lot	20	597.0	739.0	142.0	8.9	816.5	77.5	4.9	219.5	5.01	36.8
2	10% Molasses	19	609.5	703.2	93.7	7.6	737.9	34.7	10.8	128.4	7.37	21.2
3	15% Molasses	19	594.7	653.6	58.9	5.4	670.5	16.8	8.0	75.7	12.03	12.7

*Cottonseed meal omitted and dried buttermilk increased to 15 per cent in all lots in 1935.

TABLE 14

FATTENING HENS 1934

Eleven Day Test—January 15 through January 25—R. I. Red Hens

Lot No.	No. Hens Per Lot	Comparison of Rations	Aver. Wt. At Start of Test	AVERAGE WEIGHTS AT END OF THE TEST					Dressed Weight As Per Cent of Live Weight	Trussed Weight As Per Cent of Live Weight	Per Cent Gain of the Lot For Period
				Live Wt.	Gain in Weight	Std. Dev. of Mean of Gains	Dressed Weight	Trussed Weight			
1	10	Check Lot	2258	2466	208	30.44	2302	1859	93.22	74.80	9.21
2	10	10% Molasses	2112	2218	105	44.05	2072	1724	93.42	77.73	4.97*
3	10	15% Molasses	2284	2568	284	22.97	2351	2046	91.55	79.67	12.43
4	6	Yel. Corn and Skimmilk only	2533	2713	180	------	------	------	------	------	7.11

* Two hens of this lot lost weight during the test. When these are omitted the gain for this lot is 7.06 per cent.

A fattening test with four lots of hens was made in 1934. The results are shown in Table 14. The hens fed 15 per cent molasses gained more than the check lot birds, while those on the 10 per cent molasses ration gained less than those receiving the basal ration. The small average gain of Lot 2 is explained at least partially by the fact that two hens in this lot lost weight during the test. Lot 4 hens gained somewhat less than those in Lots 1 and 3, but about the same as those in Lot 2, if the two birds that lost weight are disregarded. The gains were not unusually good in any of the lots, but since the hens were in good condition at the beginning of the test large gains could not be expected. The dressing loss (blood and feathers loss) differed very little for the several lots, but the molasses fed hens showed better carcasses as gauged by trussed or oven dressed weights as percentage of live weight. Further tests must be made to verify or refute this observation.

FLAVOR OF MEAT

Some attempt was made to ascertain if broilers that had been finished on different rations had any difference in taste. The broilers were cooked separately and were seasoned as usual. The persons participating in these tests did not know what the birds had been fed nor the lot from which they came. They were asked to give their preference, if any, for white meat, dark meat and giblets of birds from the several lots. The results as given in Table 15 indicate that no consistent preference was shown for birds from any given ration. A second type of test was conducted by the home economics department in which the birds were cooked without the addition of any seasoning. Again the results did not favor any lot significantly.

TABLE 15

PREFERENCE OF COOKED MEAT—BROILERS

1934 TEST

	Number People Participating	MEAT PREFERRED			No Preference*
		Lot 1	Lot 2	Lot 3	
White Meat	12	1	0	0	11
Dark Meat	12	0	0	2	10
Giblets	12	0	0	0	12
		1935 TEST			
White Meat	17	5	3	2	7**
Dark Meat	17	4	5	2	6
Giblets	17	2	1	0	14

* One person stated that the dark meat of Lot 1 bird had an oily taste.
** Three persons stated meat of Lot 2 bird was juicier.
Two persons stated meat of Lot 1 bird had a tendency to be soft.
Three persons stated meat of Lot 3 bird was more moist.

Summary and Conclusions

MOLASSES IN LAYING RATIONS

Blackstrap molasses in the laying ration did not increase feed consumption appreciably but did cause an increased consumption of water.

In three cases average egg production was slightly lower in lots fed rations containing molasses than in lots fed similar rations without molasses, while production of seven molasses fed lots equaled or exceeded that of the check lots. The production of the hens fed rations containing molasses was at least equal to that of birds receiving no molasses and at prices prevailing locally the molasses rations were less expensive.

It was evident that 10 per cent molasses in an all-mash ration was a maximum, if not an excess, that it is advisable to use in laying rations. The litter in these pens became damp and sticky quickly and the droppings were very watery at all times. However, such a laxative diet did not markedly impair the health or laying ability of the hens. In this section of the country where it is abundant and relatively cheap molasses can well be used more extensively to replace corn meal or other carbohydrate feed to the extent of 15 per cent of a laying mash to be fed with grain or 7.5 per cent of an all-mash ration.

Mortality was somewhat higher in the molasses fed lots but since it did not vary in proportion to the amount of molasses in the diet it is doubtful that molasses was the cause of the higher mortality.

Egg size apparently was not influenced by molasses feeding and the hatching quality of the eggs was not affected appreciably.

No ration produced a consistent advantage in body weight, although it was noted that the groups fed molasses tended to average heavier for the year than the check lots. On the other hand the lots receiving molasses showed a somewhat greater decline from maximum weight toward the end of the year. For the two years during which the experiments continued for ten months a distinct decrease in weight in July and August occurred. This tendency to lose weight during the summer and early fall has been noted in all pullets weighed at this station during the past eight years. Method of feeding and ration influence the extent of decrease in weight, but the downward trend always occurs. The cause is not known but the decline may be due to climatic conditions.

MOLASSES IN CHICK RATIONS

The all-mash ration containing 10 per cent molasses, replacing rice bran, was definitely inferior to a similar ration containing rice bran. The all-mash ration which included 15 per cent blackstrap molasses replacing yellow corn meal pound for pound did not produce as rapid gains as a similar ration containing no molasses. Some birds grew normally in the 15 per cent molasses lots, but this ration was entirely too laxative for most of the chicks. This apparently resulted in uneven growth in these lots. Rations in which yellow corn meal is replaced by blackstrap molasses at a 5 per cent or a 10 per cent level will produce practically as good growth, and such rations are used as efficiently, as a similar ration which contains no molasses. Since 10 per cent molasses appears to be a maximum amount that Leghorn chicks can utilize, it is recommended that not more than 5 per cent to 7 per cent be used in all-mash chick rations.

No great difference in mortality of chicks occurred in the several lots although it tended to be higher in lots 4 and 5, fed rations higher in molasses content. Perosis occurred consistently in the lots in which rice bran was omitted.

MOLASSES IN FINISHING RATIONS

Rations containing 10 per cent or 15 per cent blackstrap molasses should not have a high buttermilk content. Such rations are too laxative. However, finishing rations containing 8 per cent dried buttermilk and 7 per cent cottonseed meal and molasses produced good gains. Battery grown leghorn broilers made gains ranging from 26 per cent to 47 per cent in two weeks when fed such rations. The rations containing 10 per cent and those with 15 per cent molasses produced gains equal to those of the non-molasses ration when the dried buttermilk level was 8 per cent. In a single test the trussed or oven dressed weights of hens fed rations containing molasses were greater, as compared to live weights, than those of hens receiving no molasses. Further tests must be made to verify or refute this observation.

Attempts were made to test the palatability of broilers finished on different rations. No differences were evident.

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The Farmstead

LOUISIANA BULLETIN No. 290 AUGUST, 1937

RURAL HOUSING IN LOUISIANA

By

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Rural Housing In Louisiana*

By

ELLEN LeNOIR and T. LYNN SMITH

INTRODUCTION

This study is an attempt to set forth in detail some of the most important features of the homes in which the rural families of Louisiana live. It attempts to determine the adequacy of rural housing in Louisiana, in so far as the home may be judged by the condition of the house, the space that it provides for the life of its occupants, the kinds of rooms it contains, and the extent to which it has been equipped with modern conveniences. An attempt will be made to indicate some of the factors responsible for variations in the housing conditions in the different portions of the state.

1. **Objectives of the study:** Among the specific objectives of the study are the following:

A. To describe some of the outstanding features of rural homes in Louisiana.

B. To determine the significant differences in the housing of whites and Negroes, owners and tenants.

C. To examine the associations of housing factors with the various types of farming and with differences in the cultural heritage.

2. **Importance of the study:** A foundation of facts is needed as a basis for the Louisiana home demonstration program of the immediate future and for the establishment of ultimate goals for the service of the home demonstration agents to the rural families of the state. Home improvements have been planned by rural home-makers and advised by extension workers on the basis of the information that they had. In many cases the exact information available has been very limited. In recent years the changes in Louisiana rural life as in the whole of American rural life have been so significant that the home-maker and the extension worker need more definite information upon which to predicate their plans. Improved means of communication and transportation have brought the rural family and the city family so close together that it behooves the rural householder and the rural sociologist to inquire into the results of different housing standards.

In recent years paved highways and improved roads have brought most of Louisiana's rural families within reasonable distance of the amusements of urban centers. Low-priced automobiles have contributed to a change in the kind of recreation that is common among farm residents. The development of the present educational system of the state has brought about changes in the desires and possible attainments of rural youth. Expenditures for all of these items compete actively with housing needs for the funds that rural families have to spend. Whether young people will, in the future, be satisfied with farm life is a significant question. The comfort and style of rural homes are important factors in this problem.

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* This bulletin is a condensation and revision of a thesis, "Rural Housing in Six Selected Louisiana Parishes," prepared by Ellen LeNoir under the direction of T. Lynn Smith, and presented in partial fulfilment of the requirements for the degree of Master of Arts, Louisiana State University, July, 1937.

Agricultural policies have changed also, of necessity, along with the changes mentioned above. The Agricultural Adjustment Administration, the Rural Electrification Administration, and other New Deal agencies are bringing about changes in rural organization and corresponding changes in the plans of farm women for their homes—their houses and the life within them —and in the plans of the home demonstration agents who try to advise the farm women. It is hoped that this study may contribute basic information upon which to build programs of rural home improvement, sound programs which will be based upon a knowledge of what is needed, what is desired, what can be afforded, and how the three are related.

3. **Scope.** This study is limited to an analysis and a description of the housing situation, with an analysis of a few outstanding factors that explain variations of rural housing in Louisiana and the relationships between these housing facts and some agricultural and sociological aspects of the areas surveyed.

In the early months of 1934, a rural housing survey was conducted in 46 states by the Bureau of Home Economics, the Agricultural Extension Division of the Land Grant Colleges, and the Federal Emergency Relief Administration of the states. This survey, planned by the Bureau of Home Economics, covered one-tenth of the counties in each state, chosen to represent the various topographical divisions and types of agriculture in the state. The six Louisiana parishes surveyed were selected by the State Extension Office with this plan in mind.

R. L. Thompson lists four divisions[1] of Louisiana (with one of these subdivided) with regard to main types of agriculture; the areas of cotton (subdivided into upland cotton and delta cotton), of rice, of cane, and of small fruits and vegetables. Because the plan for the survey provided for covering six parishes and because there are two rather distinct groups within the parishes of the upland cotton area, this cotton area as given by Dr. Thompson was divided into the upland cotton and the cut-over sections. The six parishes selected for the survey are as follows: Acadia, representing the rice area; Beauregard, representing the type of farming on cut-over land; Claiborne, representing the upland cotton area; Lafourche, representing the cane area; Livingston, representing the area of small fruits and vegetables; and Tensas, representing the delta cotton area. These six parishes are fairly representative of the main types of farming in the state. It is interesting to note that the 16,403 houses for which schedules were taken constitute almost one-tenth of the farm houses of the state, according to the last census before the survey.[2]

4. **Methodology.** During the latter part of 1933 plans were sent to the states by Dr. Louise Stanley, Chief, Bureau of Home Economics, for the rural housing survey which was made in the early part of 1934. An account of

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[1] R. L. Thompson, "The Agricultural Credit Situation in Louisiana," Louisiana State University Agricultural Experiment Station Bulletin No. 208, 1930, p. 6.

[2] Fifteenth Census of the United States; 1930, Population Bulletin, "Families," Louisiana, p. 10.

the organization of the survey in this state is quoted from the report of Miss Fournet and Mrs. Coxe.[3]

> Dr. Louise Stanley, Chief of the Bureau of Home Economics notified Mr. J. W. Bateman, Director of Agricultural Extension Division of Louisiana State University, of the approval by the Civil Works Administration of a Federal project on Rural Housing. This was about the middle of December, 1933. She requested him to appoint a member of the Home Demonstration Staff as State Director of the project and an Agricultural engineer as Vice Director. Mr. Bateman, after conferring with Miss Ellen LeNoir, State Home Demonstration Agent, appointed Miss Estelle Fournet, Special Agent, as State Director and C. J. Hutchinson, Agricultural Engineer, as Vice Director.
>
> In accordance with Dr. Stanley's instructions, the Preliminary Planning Committee for Louisiana was made up of the following persons:
>
> Miss Estelle Fournet, State Director of the Farm Housing Survey.
>
> C. J. Hutchinson, Vice Director of the Farm Housing Survey.
>
> J. W. Bateman, State Director of Agricultural Extension.
>
> Miss Ellen LeNoir, State Home Demonstration Agent.
>
> Dr. Helen M. Carter, Head of the Home Economics Department.
>
> H. T. Barr, Representative of the Agricultural Engineering Department.
>
> This committee discussed various phases of the project and decided to ask Mrs. Hazel Grimm Coxe, former Assistant State Supervisor of Home Economics, to act as State Supervisor.
>
> On Thursday, December 21, 1933, Miss LeNoir, Miss Fournet, and Mrs. Coxe attended a conference in New Orleans conducted by Miss Nell Pickens of Alabama. Miss Pickens had been sent out by the Washington office to hold instruction meetings. Representatives from Texas, Mississippi, and Florida were also there.
>
> During the week of December 25, Miss Fournet or Mrs. Coxe visited each of the six parishes selected for the survey. Contacts were made with the Civil Works Administration Administrators, and the National Reemployment Service Directors. Whenever possible, conferences were held with the home and farm agents and the parish superintendents of schools. An effort was made to get in touch with unemployed school teachers, and unemployed stenographers or women with clerical experience. A chairman and building engineer were selected for each parish.
>
> On Tuesday, January 2, a State Training meeting was held in Baton Rouge. All parish chairmen and building engineers were present. There was a full discussion of the information dealing with the Farm Housing Survey which, up to that time, had been received by the State Director.

Enumerators paid by the Civil Works Administration, as were all of the paid workers on the project (the members of the Planning Committee were lent to this work by Louisiana State University), were sent out to visit every rural home in the six selected parishes. The farmer or his wife was interviewed or in some cases both were consulted. Some homes were visited again by the parish supervisor or the engineer for checking. The schedules used were sent from the Bureau of Home Economics and contained items on various phases of the house and grounds and also questions concerning needed and desired improvements. They were checked and compiled in the parish offices and for the state in the state office; they were then checked and compiled in the Bureau of Home Economics and preliminary and sectional summaries were returned to the state.

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[3] Estelle Fournet and Hazel G. Coxe, "Summary Report of Farm Housing Survey," (unpublished manuscript) copy sent to Bureau of Home Economics, copy retained in file of Louisiana State Home Demonstration Agent, 1934.

These 16,403 individual schedules, the ward and parish summaries, and the state summary furnish a good store of material for a number of studies of Louisiana housing from various angles.[4]

In this present study, the analysis was limited to the parish summaries and to certain items regarding tenure and race of occupants, age of house and material of which it was built, number and purpose of rooms and, to that extent, the degree in which the house meets the needs of the family, and a few outstanding conveniences in housing. These data were grouped into tables in order that correlations and associations might be considered. The tabulations were compiled for the whole group, by parishes and by racial and tenure groups. The compilations and percentages were done by mechanical means. An attempt was made to associate the data with significant agricultural and sociological aspects of the problem under analysis.

OWNERSHIP OF LOUISIANA HOMES

One fundamental aspect of the housing question is whether the family owns or rents the home in which it lives. Aside from the differences of behavior of the families who live in their own homes and those who live in rented houses, and the differences in the feeling of those families, there are differences that relate to the housing itself.

The facts pertaining to the tenure of the families were tabulated and are presented in Table I. The data are classified separately for the two races.

Of the 16,403 homes surveyed, 10,333 are homes of white families and 6,070 are homes of colored families, mostly Negroes, with a few Indians and "Redbones." The homes that are owned by the families occupying them total 6,055, or 36.9 per cent, and rented homes amount to 10,348, or 63.1 per cent of the total. Thus, approximately one-third of the rural homes in Louisiana are occupied by families who own them.

On analysis of the ownership data according to race, some significant differences are found. It is seen that of the white families, 5,354, or 51.8 per cent own their homes and of the colored families only 701 or 11.5 per cent own their homes. Thus home ownership in the rural portions of Louisiana is nearly five times as high among white as among colored families.

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[4] Some human interest stories showing the attitudes of the residents interviewed about their houses were brought out in the state report of the survey:

"One of the enumerators in Tensas parish was visiting the home of an old Negro, who owned his home and a small farm. She explained to him carefully the purpose of the Farm Housing Survey and was rather gratified by his keen interest. When she had finished, he answered, 'Well I'll declare! I allus knowed George Washington was de father of dis country but dis yer Mista Rusevelt is bof de mammy and de pappy.'

"Another Negro man who was a tenant in Tensas parish amused the enumerator when, after explanation of the survey to him, he volunteered . . . 'Yo' no, Mista Huee Long, an' he's gov'ment jes does ev'thin fo'usus'."

The following letter is in contrast to many that were received from school superintendents and other leaders showing an appreciation of the objectives of the survey:

"Miss Estelle fournel:

"Dear madom i Am hear By ask you in the State to help me i Am ask you Both to Build me A three room house on my father farm are buy me a lot in the town of homer i would like it as well for i am a cripple woman with three children to loak out for an yo no we all have a hard time Because i am unable to work an i hope that you will help me i have Ben in this cripple Every since i was five year old and now is 34 and i think the State woulden mine fealen my scempthy an give me a home of my own i hope that they would give me a lot in the town of homer so i can send my children to School if i just could get the lat town and a house on it i could rase chicken for our Susport on other Side lines but if you cant give me a lot please give me a three room house on the farm and do it as soon as you can becuse it an no geten alone where it to Kings in the gumf.

So please let me hear from you by return mail I read where it seavel millions of dollars is coming to help the needess people an i hope and no i am one so help me all you can."

See ibid., pp. 22-24.

TABLE I. OWNERSHIP OF RURAL HOMES IN SIX SELECTED LOUISIANA PARISHES CLASSIFIED ACCORDING TO RACE OF OCCUPANTS

Parishes	Total Number of Homes	Number Occupied by Whites	Number Occupied by Colored	OWNERSHIP					
				Total		White		Colored	
				No. Owned	Per Cent Owned	No. Owned	Per Cent Owned	No. Owned	Per Cent Owned
Acadia	3,575	3,125	450	1,262	35.3	1,200	38.3	62	13.7
Beauregard	1,371	1,276	95	1,017	74.2	976	76.4	41	43.1
Claiborne	4,118	1,439	2,679	1,286	31.2	868	60.3	418	15.6
Lafourche	2,184	1,829	355	296	41.0	872	47.6	24	6.7
Livingston	2,412	2,117	295	1,431	59.3	1,346	63.5	84	28.4
Tensas	2,743	547	2,196	164	5.9	92	16.8	72	3.2
Total	16,403	10,333	6,070	6,055	36.9	5,354	51.8	701	11.5

TABLE II. AGE OF RURAL HOUSES IN SIX SELECTED LOUISIANA PARISHES CLASSIFIED ACCORDING TO RACE AND TENURE OF OCCUPANTS

Age of Houses	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total houses	*16,319	100	3,575	100	1,371	100	4,118	100	2,184	100	*2,328	100	2,743	100
Under 10 years	3,757	22.9	594	16.6	523	38.3	1,117	27.1	231	10.6	954	40.9	338	12.4
10 to 24 years	4,855	28.8	1,299	36.3	520	37.9	1,400	34.0	510	23.4	701	32.2	425	15.5
25 to 49 years	5,774	35.4	1,437	40.2	287	20.9	1,165	28.3	376	40.1	556	23.9	1,454	52.9
50 years and over	1,933	11.9	245	6.9	41	2.9	436	10.6	567	25.9	117	5.0	527	19.2
WHITE OWNERS														
Total houses	5,254	100	1,200	100	976	100	868	100	872	100	1,346	100	92	100
Under 10 years	1,490	27.8	197	16.4	364	37.2	206	23.7	169	19.4	521	38.7	33	35.9
10 to 24 years	1,689	31.5	412	34.3	371	38.0	228	26.3	224	25.7	440	32.7	14	15.2
25 to 49 years	1,673	31.2	514	42.8	207	21.2	299	34.4	303	34.7	327	24.3	23	25.0
50 years and over	502	9.5	77	6.5	34	3.6	135	15.6	176	20.2	58	4.3	22	23.9

WHITE TENANTS														
Total houses	4,979	100	1,925	100	300	100	571	100	957	100	771	100	455	100
Under 10 years	1,064	21.4	332	17.3	118	39.3	144	25.2	56	5.9	332	43.1	82	18.0
10 to 24 years	1,594	32.0	712	37.0	155	38.3	172	30.2	261	27.3	232	30.1	102	22.4
25 to 49 years	1,727	34.7	736	38.2	61	20.4	187	32.7	392	41.0	158	20.5	193	42.4
50 years and over	594	11.9	145	7.5	6	2.0	68	11.9	248	25.8	49	6.3	78	17.2
COLORED OWNERS														
Total houses	701	100	62	100	41	100	418	100	24	100	84	100	72	100
Under 10 years	170	24.3	7	11.3	14	34.1	105	25.1	3	13.0	22	26.2	19	26.4
10 to 24 years	229	32.7	17	27.4	14	34.1	152	36.4	5	20.1	23	27.4	18	25.0
25 to 49 years	232	33.1	32	51.6	12	29.3	116	27.8	13	53.9	31	36.9	28	38.9
50 years and over	70	9.9	6	9.7	1	2.5	45	10.7	2	13.0	8	9.5	7	9.7
COLORED TENANTS														
Total houses	5,285	100	388	100	54	100	2,261	100	331	100	*127	100	2,124	100
Under 10 years	1,033	19.5	58	14.9	27	50.0	662	29.3	3	0.9	79	62.2	204	9.6
10 to 24 years	1,343	26.1	158	40.7	20	37.0	848	37.5	20	6.0	6	4.7	291	13.7
25 to 49 years	2,142	39.9	155	39.9	7	13.0	563	24.9	168	50.8	40	31.3	209	56.9
50 years and over	767	14.5	17	4.5	0	0	188	8.3	140	42.3	2	1.6	420	19.8

* The information on the age of house is lacking for 84 houses of colored tenants in Livingston; so these percentages are figured on a total of 127 houses instead of 211; the totals in Livingston parish are figured on the basis of 2,328 instead of 2,412; the totals among colored tenants on the basis of 5,285 instead of 5,369; and the totals for the six parishes on 16,319 instead of 16,403.

Associated with the difference between whites and Negroes is the fact that home ownership is relatively high in the parishes in which family farms prevail, as in the rich land of the trucking section, in the hilly portions of the state, and on the cut-over land. On the other hand, home ownership is low in the lowland sections where cotton and cane are grown. In the Red River and Mississippi deltas these crops have, for generations, been produced on a large scale, under a plantation system where one entrepreneur supervises the work of many manual laborers. Most of the laborers in the cotton fields and the cane fields have been Negroes, slaves before the Civil War and share croppers or wage hands since that time. Thus home ownership is lowest in Tensas Parish, which is almost entirely cotton-growing in its agriculture; next lowest in Claiborne, representing cotton plus diversification; next in Lafourche, which represents the cane plantations with enough small truck farms to bring total ownership up to 41.0 per cent; and over 50 per cent in only Livingston and Beauregard parishes, where trucking and general farming on a rather small scale are practiced.

In the matter of fertility of soil, again the data show ownership to be lowest in Tensas where the land is most fertile and highest in Beauregard where the land generally is poorest. In Lafourche, where the land is more fertile than in any other of the six parishes, except Tensas, the percentage of ownership is not so low as in Acadia and Claiborne because at least two other factors affect ownership in Lafourche; the French influence in Lafourche tends toward small farms, and the suitability of the rich soil and the climate of Lafourche to production of truck crops breaks up areas that would otherwise be plantations with large numbers of tenants and low percentage of ownership. In general, cotton and cane plantations have preempted the better soils of the state, a fact which makes the findings regarding the ownership of homes readily understandable.

In conclusion, certain definite facts regarding ownership are brought out by examination of the data from the parishes surveyed. The data show that, for the total of the six parishes, 36.9 per cent of the rural homes are owned by their occupants. Home ownership is approximately five times as prevalent among whites as among Negroes. Of the homes of white families 51.8 per cent are owned; and of the homes of colored families, only 11.5 per cent are owners' homes. Ownership is high in the poor-land sections of the state. It is high also in the fertile sections that have been given over to truck crops and the areas where the French ancestry of the people is responsible for a cultural pattern in which the land system is based upon small plots cultivated by the family.

AGE OF RURAL HOUSES

In this section data concerning the ages of houses in the six sample parishes are presented and analyzed. On the whole these data show certain facts in regard to age to be fairly constant throughout the six parishes, and also show certain relationships between the age of the house and the standard of living of the family. Unfortunately, information regarding age is lacking for 84 houses of colored tenants in Livingston parish, making the total number of houses classified as to age 16,319, instead of the 16,403 houses of the survey. Despite this defect, the data still constitute a significant body of concrete information concerning this aspect of rural housing in Louisiana. In Table II are presented the data concerning the ages of houses in the state.

To facilitate comparisons these data are classified according to the race and tenure status of the occupants.

All in all, the farm houses of Louisiana are relatively new; 52.7 per cent are less than 25 years old. Nearly one-fourth (22.9 per cent) are less than 10 years old. Even among the older houses, in the totals for the six parishes, only 11.9 per cent are more than 50 years old.

The age of the house is correlated in important ways with certain social and economic factors. For example, new houses are found most frequently in the parishes where ownership is highest (Beauregard and Livingston parishes). Beauregard Parish represents the cut-over section settled in recent years since the timber was removed, and a part of Livingston Parish is in the trucking area. Many of these new houses in Beauregard, therefore, of both owners and tenants, are the shacks that were thrown up on the poor farms from which the lumber mills had recently moved. In Livingston, some are the homes of foreigners who recently have come into the strawberry section.

On the other hand, the relatively high percentages of old houses are associated with fertile soil and, to some extent, with the plantation system. The highest percentage of old houses in the six parishes surveyed is in Tensas, where 52.9 per cent are from 25 to 49 years old, and 19.2 per cent are 50 years old or over. Old houses are also prevalent in Lafourche, where 40.1 per cent are from 25 to 49 years old and 25.9 per cent are 50 years old or over. Because the highest percentages of old houses, those 50 years old or more, are in Lafourche among cane plantations with their old mansions and among French families who have passed their smaller farms on from father to son, and in Tensas, where there are cotton plantations, the adequacy of housing should not be judged too much in terms of the age of the homes.

The relationship between tenure and the age of the houses is interesting. The percentages of new houses are higher among owners, both white and colored, than among tenants of either group. But in the two piney woods or cut-over parishes, Beauregard and Livingston, the houses of both white and colored tenants are newer than those of the owners. The same is true in Acadia and Claiborne parishes.

It is interesting to compare the ages of houses occupied by white families with those of houses occupied by Negroes. The data in Table II indicate that the homes of the white owners are slightly newer than those of colored owners, although the difference is very slight; and in Claiborne and Tensas, the two cotton parishes, the percentages of new houses among colored owners are higher than among white owners.

Among tenants, 53.4 per cent of the whites live in houses less than 25 years old, as compared with 45.6 per cent of the colored tenants. The relationship, however, is not constant throughout the six parishes. In three parishes (Acadia, Beauregard, and Claiborne) the percentage of new houses among white tenants is lower than among colored tenants. The most significant difference is in Lafourche and Tensas, the two plantation parishes; in both of these, the percentage of new houses occupied by white tenants is much higher than the percentage occupied by colored tenants.

In summarizing the findings of the survey with regard to the age of rural houses, it is seen that more than half of them are less than 25 years old, with 22.9 per cent under 10 years old and 29.8 per cent 10 to 24 years old; that new houses are fairly evenly divided among owners and tenants and among white and colored; that the highest percentages of new houses are in Beauregard and Livingston and the highest percentages of old houses in Lafourche and Tensas. It appears that old houses are associated with the plantation system and with an established agriculture.

CONSTRUCTION OF LOUISIANA HOMES

The material of which houses are built is a factor of some significance in a study of housing. To some extent it is indicative of the available building materials but it also reflects the standards of the families residing in the houses, and it is also partially determined by the culture of the families, reflecting the folkways that have persisted for generations.

Driving through the rural sections of Louisiana one sees mainly frame houses, a very few log houses, and rarely one of brick. Analysis of the data regarding the materials of which rural houses are built in the six parishes surveyed confirms this observation. (See Table III.) Of the 16,403 rural houses, 98.3 per cent are frame, with less than 0.1 per cent brick or earth. Among all the houses, there is not one of stone or concrete. This reflects the condition that prevails over most of rural Louisiana. Timber is plentiful; sawmills have been located in the wooded sections; and it has been easy to get lumber for building houses, structures quite similar to the houses in which the progenitors of these people had lived before they came to Louisiana. In a section of Louisiana where cultural heritage goes back to Virginia, one sees a few more brick houses on the plantations (as in East Feliciana). But in the parishes of this survey, most of the native white families came from the other states of the deep South, and they built houses of wood when they settled to develop new homes. The French culture, too, is associated with frame dwellings; southern Louisiana has never known the log house. Even the mansions on the plantations have usually been of frame construction, some times of hand-hewn cypress and decorated by carving and paint, but using the available and accustomed timber.

Some of the early settlers of Louisiana came from log homes in the upland sections of the other Southern States. They built log homes for their families; a few of these are still standing and a few log houses have been built later by their descendants. This is brought out by the fact that the only log houses found in the six parishes are in Beauregard, Claiborne, and Livingston, where there are still residues of upland culture. Furthermore, these log houses are occupied almost exclusively by people who own them. Perhaps the fact that these parishes have few houses over 50 years old still standing accounts for there being such a small percentage of log houses, only 1.6 per cent for the six parishes; just as the persistence of upland culture in the region least accessible to population centers explains why the largest percentage of log houses is in Beauregard. Isolation is a fact of primary importance in explaining lack of cultural change.

Acadia, on the prairies, and Lafourche and Tensas, in the alluvial sections, have no log houses. But Acadia, with its families from the Middle West and its French, and Lafourche, with its French inhabitants, have just enough houses of earth to indicate the survival of that usage.

Next to the almost universal use of frame construction in Louisiana's rural houses, an interesting feature is the use—or lack of use—of paint. More than three-fourths of the houses are unpainted.

TABLE III. MATERIALS OF WHICH HOUSES ARE BUILT IN SIX SELECTED LOUISIANA PARISHES CLASSIFIED AS TO RACE AND TENURE OF OCCUPANTS

Material	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total Houses	16,403	100.0	3,575	100.0	1,371	100.0	4,118	100.0	2,184	100.0	2,412	100.0	2,743	100.0
Log	265	1.6	0	0	117	8.5	82	2.0	0	0	66	2.7	0	0
Earth	13	*	10	0.3	0	0	0	0	3	0.1	0	0	0	0
Frame	16,118	98.3	3,564	99.7	1,252	91.3	4,036	98.0	2,178	99.8	2,346	97.3	2,742	99.9
Unpainted	12,843	78.3	2,855	77.1	839	61.2	3,278	79.6	1,465	67.1	2,000	82.9	2,506	91.4
Painted	3,271	20.0	808	22.6	411	30.1	758	18.4	713	32.7	345	14.4	236	8.5
Stucco	4	*	1	*	2	0.1	0	0	0	0	1	*	0	0
Brick	7	*	1	0	2	0.1	0	0	3	0.1	0	0	1	0.1

(Continued)

TABLE III. (Continued)

Material	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
WHITE OWNERS														
Total Houses	5,354	100	1,200	100	976	100	868	100	872	100	1,346	100	92	100
Log	115	2.1	0	0	72	7.4	12	1.4	0	0	31	2.4	0	0
Earth	3	*	2	0.2	0	0	0	0	1	0.1	0	0	0	0
Frame	5,232	97.8	1,197	99.8	902	92.4	856	98.6	870	99.8	1,315	97.6	92	100
Unpainted	3,227	60.3	731	60.9	576	59.0	441	50.8	382	43.8	1,059	78.7	38	41.3
Painted	2,004	37.5	466	38.9	226	33.4	415	47.8	488	56.0	255	18.9	54	58.7
Stucco	1	*	0	0	0	0	0	0	0	0	1	0	0	0
Brick	4	0.1	1	0	2	0.2	0	0	1	0.1	0	0	0	0
WHITE TENANTS														
Total Houses	4,979	100.0	1,925	100.0	300	100.0	571	100.0	957	100.0	771	100.0	455	100.0
Log	69	1.4	0	0	30	10.0	12	3.1	0	0	27	3.5	0	0
Earth	9	0.2	7	0.4	0	0	0	0	2	0.2	0	0	0	0
Frame	4,900	98.4	1,918	99.6	270	30.0	559	97.9	954	99.7	744	96.5	455	100.0
Unpainted	4,049	81.3	1,620	84.2	195	65.0	463	81.0	739	77.2	668	86.6	364	80.0
Painted	849	17.1	297	15.4	74	24.7	96	16.9	215	22.5	76	9.9	91	20.0
Stucco	2	0	1	*	1	0.3	0	0	0	0	0	0	0	0
Brick	1	0	0	0	0	0	0	0	1	0.1	0	0	0	0

							COLORED OWNERS							
Total Houses	701	100.0	62	100.0	41	100.0	418	100.0	24	100.0	84	100.0	72	100.0
Log	24	3.4	0	0	12	29.3	12	2.9	0	0	0	0	0	0
Earth	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frame	677	96.6	62	100.0	29	70.7	406	97.1	24	100.0	84	100.0	72	100.0
Unpainted	566	80.8	54	87.1	25	61.0	325	77.7	19	79.2	80	95.2	63	87.5
Painted	111	15.8	8	12.9	4	9.7	81	19.4	5	20.8	4	4.8	9	12.5
Stucco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brick	0	0	0	0	0	0	0	0	0	0	0	0	0	0
							COLORED TENANTS							
Total Houses	5,369	100.0	388	100.0	54	100.0	2,261	100.0	331	100.0	211	100.0	2,124	100.0
Log	57	1.1	0	0	3	5.6	46	2.0	0	0	8	3.8	0	0
Earth	1	*	1	0.3	0	0	0	0	0	0	0	0	0	0
Frame	5,309	98.9	387	99.7	51	94.4	2,215	98.0	330	99.7	208	96.2	2,123	99.9
Unpainted	5,001	93.1	350	90.2	43	79.6	2,049	90.6	325	98.2	193	91.5	2,041	96.1
Painted	307	5.8	37	9.5	7	13.0	166	7.4	5	1.5	10	4.7	82	3.8
Stucco	1	0	0	0	1	1.8	0	0	0	0	0	0	0	0
Brick	2	0	0	0	0	0	0	0	1	0.3	0	0	1	0.1

*Less than 0.1 of one per cent.

In all of the six parishes, there are more homes of white families painted than homes of colored; the percentages run in the following order—though all are comparatively low: white owners, white tenants, colored owners, and colored tenants. There is a single exception; in Claiborne, the percentage of colored owners whose houses are painted is larger than the percentage among white tenants. The group of Negro owners throughout northwest Louisiana is a progressive group who are making an effort to raise the standard of living of their people.

The slight difference between white tenants and colored owners in the matter of painted houses is less significant than the variations among the six parishes. There are three parishes in which the percentage of painted houses runs above the percentage for the total and three in which it runs below. The three in which it runs above are Lafourche, Beauregard, and Acadia. This is an interesting example of the persistence of traits that people brought with them from their former homes when they came to settle in Louisiana. In Lafourche, the French people are accustomed to making their homes neat and one of the ways of doing it is by painting. In Beauregard, besides the strain of southern upland stock who built the log houses, there is a group of more recent settlers, only a few generations away from sturdy German peasant stock, who came to Louisiana from the Midwest. These families brought with them the tradition of painted houses. In Acadia there are both French and Midwestern families. In the other three parishes, most of the white families came from other states of the deep South, where paint is somewhat of a luxury.

In summarizing these facts regarding construction of houses, it may be said that the frame house is the house of rural Louisiana; that in sections where there persists some of the culture of the southern uplands a few log houses are found; that in sections of French and Midwestern influence a few earth houses survive, but so few that they are of very little importance; that the brick houses are too few to be of significance; and that, except in sections where French and Midwestern influences are strong, less than 20 per cent of the houses are painted.

ADEQUACY OF LOUISIANA'S RURAL HOMES

Adequacy of housing is largely subjective and might be measured by different persons in a variety of ways. It is, nevertheless, a highly important aspect of the housing problem. In this study, an attempt is made to form some judgments in this respect by using as indices a few definite items that were reported upon in the survey.

The first item considered is the number of rooms in the house in connection with the number of occupants; for whether the family has space for its members to live in comfortable and decent privacy, or whether the members are crowded together, is an important measure of the way in which the house meets the needs of the family.

Whether the house has a separate living room is an important factor in measuring the way in which the house not only meets the needs of the family, but also helps to establish the standard of living. There is likely to be one standard in the family that has a separate living room where the members can gather for recreation, rest, companionship, reading, study, conferences on family affairs, or where guests can be entertained—sometimes the

TABLE IV. ADEQUACY OF HOMES IN SIX SELECTED LOUISIANA PARISHES CLASSIFIED AS TO RACE AND TENURE OF OCCUPANTS

Total Houses	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total Homes	16,403	100	3,575	100	1,371	100	4,118	100	2,184	100	2,412	100	2,743	100
Average No. Acres in Farm	86.1	------	61.4	------	48.4	------	102.0	------	69.8	------	47.5	------	247.6	------
Average No. Acres tillable	47.6	------	48.6	------	16.7	------	49.97	------	40.5	------	8.9	------	119.1	------
Average No. Rooms in House	4.2	------	4.0	------	4.0	------	4.6	------	4.2	------	3.8	------	3.9	------
Average No. Occupants	4.7	------	5.3	------	4.8	------	5.0	------	5.0	------	4.6	------	4.0	------
Homes with Living Room	4,081	24.9	1,127	31.5	608	44.3	710	17.2	698	31.9	805	33.4	133	4.9
Homes with Dining Room	6,564	40.0	1,324	37.0	657	47.9	2,088	50.7	622	28.5	1,092	45.3	781	28.5
Homes with Bathroom	993	6.5	275	7.7	113	8.6	123	3.0	227	10.4	164	6.8	91	3.3
Homes with Front or Side Porch	12,770	77.9	2,142	59.9	1,190	90.4	3,371	81.9	1,948	89.2	1,677	69.6	2,442	89.0
Homes with Back Porch	5,537	33.8	1,330	37.2	868	65.9	1,603	38.9	813	37.2	625	25.9	298	10.9

TABLE IV. (Continued)

	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
WHITE OWNERS														
Total Homes	5,354	100	1,200	100	976	100	868	100	872	100	1,346	100	92	100
Average No. Acres in Farm	184.7	------	120.7	------	59.2	------	152.4	------	64.3	------	43.2	------	669.6	------
Average No. Acres Tillable	82.1	------	84.0	------	17.9	------	61.7	------	28.6	------	11.8	------	308.6	------
Average No. Rooms in House	5.1	------	5.0	------	4.6	------	5.7	------	5.4	------	4.6	------	5.3	------
Average No. Occupants	4.6	------	4.8	------	4.6	------	4.4	------	5.1	------	5.0	------	3.8	------
Homes with Living Room	2,473	46.2	613	51.1	477	48.9	315	36.3	429	49.2	583	43.3	56	60.9
Homes with Dining Room	2,850	53.2	681	56.8	623	53.6	703	81.0	127	14.6	742	55.1	74	80.4
Homes with Bathroom	753	14.1	199	16.6	96	9.8	92	10.6	172	19.7	146	10.9	48	52.2
Homes with Front or Side Porch	4,499	84.0	903	75.3	857	87.7	810	93.3	806	92.4	1,043	77.5	80	86.9
Homes with Back Porch	2,923	54.6	711	59.3	651	66.7	622	71.7	436	50.0	449	33.4	54	58.7

TABLE IV. (Continued)

	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
WHITE TENANTS														
Total Homes	4,979	100	1,925	100	300	100	571	100	957	100	771	100	455	100
Average No. Acres in Farm	95.1	—	60.4	—	50.1	—	91.2	—	93.3	—	55.2	—	220.4	—
Average No. Acres Tillable	47.3	—	51.5	—	12.0	—	40.6	—	64.3	—	9.4	—	105.8	—
Average No. Rooms in House	3.7	—	3.7	—	3.9	—	4.3	—	4.2	—	3.7	—	3.7	—
Average No. Occupants	5.0	—	5.0	—	4.8	—	5.0	—	5.8	—	4.6	—	4.8	—
Homes with Living Room	1,131	22.7	484	25.1	110	36.7	66	11.6	241	25.2	184	23.9	46	10.1
Homes with Dining Room	1,853	37.2	573	29.8	102	34.0	297	52.0	419	43.8	286	37.1	176	38.7
Homes with Bathroom	203	4.1	71	3.7	17	5.7	11	2.0	52	5.4	18	2.3	34	7.5
Homes with Front or Side Porch	3,605	72.4	1,020	53.0	251	83.7	520	91.1	906	94.7	508	65.9	400	87.9
Homes with Back Porch	1,511	30.3	556	28.9	163	54.3	245	42.9	328	34.3	138	17.9	81	17.8

TABLE IV. (Continued)

	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
							COLORED OWNERS							
Total Homes	701	100	62	100	41	100	418	100	24	100	84	100	72	100
Average No. Acres in Farm	53.4	------	39.4	------	41.6	------	117.2	------	21.2	------	13.5	------	82.7	------
Average No. Acres Tillable	28.8	------	35.9	------	14.4	------	62.0	------	7.8	------	6.0	------	46.8	------
Average No. Rooms in House	4.3	------	4.0	------	3.6	------	4.7	------	4.1	------	4.0	------	3.8	------
Average No. Occupants	4.7	------	5.4	------	5.3	------	5.7	------	4.5	------	4.5	------	3.8	------
Homes with Living Room	327	46.6	12	19.4	6	14.6	276	66.0	6	25.0	24	28.6	3	4.2
Homes with Dining Room	515	73.5	23	37.1	7	17.1	409	97.8	11	45.8	27	32.1	38	52.8
Homes with Bathroom	18	2.6	3	4.9	0	0	10	2.4	2	8.3	0	0	3	4.2
Homes with Front or Side Porch	609	86.9	49	79.0	34	82.9	380	90.9	23	95.8	55	65.5	68	94.4
Homes with Back Porch	326	46.5	14	22.6	25	61.0	245	58.6	10	41.7	20	23.8	12	16.7

TABLE IV. (Continued)

Colored Owners	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
COLORED TENANTS														
Total Homes	5,369	100	388	100	54	100	2,261	100	331	100	211	100	2,124	100
Average No. Acres in Farm	51.2	------	25.3	------	42.9	------	47.7	------	95.5	------	78.1	------	18.0	------
Average No. Acres Tillable	25.3	------	23.0	------	22.8	------	35.6	------	61.5	------	9.3	------	15.3	------
Average No. Rooms in House	3.7	------	3.4	------	3.9	------	3.7	------	3.1	------	3.2	------	2.9	------
Average No. Occupants	4.8	------	6.2	------	4.6	------	5.1	------	4.6	------	4.5	------	3.8	------
Homes with Living Room	150	2.8	18	4.6	15	27.8	53	2.3	22	6.6	14	6.6	28	1.3
Homes with Dining Room	1,346	25.1	47	12.1	25	46.3	679	30.0	65	19.7	37	17.6	493	23.0
Homes with Bathroom	19	0.4	2	0.5	0	0	10	0.4	1	0.3	0	0	6	0.3
Homes with Front or Side Porch	4,057	75.6	170	43.8	48	88.9	1,661	73.5	213	64.4	71	33.6	1,894	84.4
Homes with Back Porch	777	14.5	49	12.6	29	53.7	491	21.7	39	11.8	18	8.5	151	7.0

friends of the mother and father, sometimes the beau of the grown daughter, and sometimes the playmates of the children. There is likely to be quite a different standard in the family where there is no separate living room in the home and where all of these activities, if participated in at home, must be relegated to the bedroom, usually of the mother and father, sometimes of the family.

Another measure of the adequacy of the dwelling is the presence or absence of a dining room. If the rural home lacks a dining room, the eating is done in the kitchen. The farm kitchen is frequently used for laundry work, for the care of milk, and for many other kinds of work, making it difficult to have a part of it that is set aside for the meals. Under these conditions meals are likely to be more eating than dining, and it requires rather persistent good breeding in the parents to enable them to teach the children correct table manners.

The bathroom is the next element considered in studying the adequacy of the house. Although for many years many persons have been clean with only a bowl and pitcher in the bedroom, having water available and a place prepared for bathing is conducive to the establishment of habits of personal cleanliness. There are many different types of bathroom, according to the means and desires of the families. The generally accepted idea of bathroom is a room equipped with the three standard pieces of bathroom equipment; but some rooms that do not conform to this pattern still serve the purpose. That a good many bathrooms in rural homes are not equipped with a flush toilet is revealed by the fact that the survey data do not show as many indoor toilets as bathrooms. A few of these bathrooms have a shower but no tub and some have a tub but no stationary lavatory. A few have even been seen that have the fixtures, especially the tub, but have not the water piped in yet. This permits the tub to be used, with the necessity for carrying the water in but provision for it to run out. In this study a bathroom is interpreted to mean any room that is set aside for bathing and equipped with tub or shower.

Porches are considered in this study of adequacy of houses because, in the hot climate of Louisiana, they contribute immensely to the comfort of the family. A front or side porch provides a place for the rural family to sit for rest, reading, or recreation at noon, in the evening, or at such other times as the work of the farm will permit; a back porch provides a comparatively cool place for doing some of the household work in more comfort than is usually possible in the kitchen with its wood stove.

Still other yardsticks of adequacy might be considered, but the limitations of this study will confine the measuring of the way in which the house takes care of the needs of the family to these few items of the survey. On the basis of most of them, adequacy shows a closer correlation with ownership and race, or with economic status of the residents, than with cultural heritage. This is made evident by examining the data in Table IV.

For the total houses of the six parishes, the average number of rooms in each house is 4.2 and the average number of occupants is 4.7; stated in another way, the average for the rural home in these six parishes is between 0.8 and 0.9 of a room per person, or 1.1 persons per room. The white owners in Tensas average 1.5 rooms per person; those in Claiborne, 1.3; and in Livingston, the only one of the six parishes where the white owners have not more rooms in their houses than occupants, the average is 0.9 of a room per person. The white tenants are much more crowded than owners, for in each of the six parishes as well as in the total, their average number of occupants runs higher than their average number of rooms in the house. Among colored owners, this same condition is true, with the exception of Tensas where the average numbers of rooms and of occupants are equal. Among colored tenants in every one of the six parishes, the average number of rooms in the house is much smaller than the average number of occupants. The colored tenants are in this respect, as in all others, by far the most poorly housed of the racial and tenure groups. In all of the parishes except Beauregard, the houses of colored owners average larger than those of white tenants. This is an interesting fact, and one which is essentially in accordance with the other comparisons that may be made between these two groups.

When it is considered that some of these rooms are kitchens, living rooms, and dining rooms, it is realized that most of the rural houses lack sufficient bedrooms for each to be occupied by not more than two persons or else they lack a separate living room.[1]

A front or side porch, a facility that contributes so much to the comfort and pleasure of Louisiana families through the long, hot summer, is a feature of a higher percentage of rural homes than any other one of these rooms that add to the enjoyment of life. This is true of the total houses of the survey and of the total for each of the six parishes. It is true also of each of the four groups, white owners and tenants, colored owners and tenants, in all the parishes, with the one exception of colored owners in Claiborne. Among colored owners in this parish a larger percentage of houses have a dining room than a front or side porch. The percentages of both, however, are very high in this group, 97.8 per cent of the homes having a dining room and 90.9 per cent having a front or side porch.

The percentages of both living rooms and dining rooms are highest in the parishes where ownership is highest. Also the percentages for the totals of the six parishes are higher among owners, both white and colored, than among tenants of either group. It is a surprise to find that they are higher among colored than among white owners, although it must be remembered that the number of colored owners is comparatively small (701 out of a total of 16,403) and that these owners are outstanding members of their race.

The bathroom is the one of these rooms associated with a high standard of living that these data show to be present in the smallest percentage of rural homes in the six Louisiana parishes. Among the total 16,403 houses, only 6.5 per cent have a bathroom. Among the parishes, the percentage is highest in Lafourche (10.4 per cent) and lowest in Claiborne (3.0 per cent) and Tensas (3.3 per cent). It is in Tensas, however, that the highest percentage among any one group is found, for 52.2 per cent of the white owners have bathrooms in their houses. These white owners in Tensas are plantation owners who handle their business on a large scale and, to some extent, carry this manner over into their social usages, living somewhat more graciously than the smaller owners who must worry about smaller details, and tending to make themselves more comfortable and to provide equipment desired.

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[1] The Louisiana State University Agricultural Extension Service has tried to encourage as part of a housing standard a living room (sometimes combined with the dining room) that is not used for sleeping, and a bedroom for not more than two persons.

In every one of the six parishes, the highest percentage of bathrooms is among white owners. The next highest is among white tenants in half the parishes, Beauregard, Livingston, and Tensas; and among colored owners in the other half, Acadia, Claiborne, and Lafourche, with the totals for the six parishes showing the highest percentage of bathrooms among white owners and the next highest among white tenants.

The other feature indicative of adequacy in housing that will be considered here is whether the house has a back porch. A back porch is a part of the working space of the woman who prepares the meals and does some other work of the home, and in the South in summer it is the comfortable part of that space. Making the woman's workshop comfortable has not been considered (or has not been accomplished) by almost two-thirds of the rural families in these six parishes, for, of the 16,403 houses, only 33.8 per cent have a back porch. It is an indication of something fine in their living that over three-fourths of the houses have a place for comfortable leisure for the whole family, with a front or side porch; but the same cannot be said in regard to making the work of the household comfortable, with only one-third having a back porch.

In summarizing these data regarding adequacy of housing it may be said that, in most respects, owners' homes are more nearly adequate than tenants', and white homes are more nearly adequate than colored. Colored owners' houses, however, are more nearly adequate than those of white tenants, in most of these measurements.

In the number of rooms and the number of occupants in the house, the houses of white owners are most nearly adequate, with the average number of rooms running a little higher than the average number of occupants. The two cut-over parishes are an exception in this case. The homes of colored owners in most cases average a little larger than those of white tenants, though for both groups, in most cases, the average number of rooms is lower than the average number of occupants; for colored tenants it is much lower. More than three-fourths of the houses are provided with front porches, although only about one-third are provided with back porches for work space. Bathrooms are present in large percentages in the homes of white owners. A higher percentage of white tenants than of colored owners have bathrooms, but this situation is reversed in three of the parishes. Living rooms and dining rooms are associated with ownership, both white and colored, but are found in only a small percentage of the houses.

CONVENIENCES IN LOUISIANA RURAL HOMES

Conveniences in the home are to some extent an index of the family's standard of living. It is true, of course, that they indicate the financial condition of the family, but, also, even among families of similar financial ability, the standard is closely related to the ways chosen for spending the income. Some of the things spoken of as conveniences are considered necessities by some families and luxuries by others. In this study consideration is given to five outstanding conveniences that are, intrinsically, matters of housing. These are water in the houses, toilets, kitchen sinks, lights, and refrigeration.

Water piped into the house so that a plentiful supply is available at the turn of a faucet is one of the greatest conveniences a housekeeper can enjoy.

TABLE V. CONVENIENCES IN HOMES IN SIX SELECTED LOUISIANA PARISHES CLASSIFIED AS TO RACE AND TENURE OF OCCUPANTS

Conveniences	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
							TOTAL HOUSES							
Total Homes	16,403	100	3,575	100	1,371	100	4,118	100	2,184	100	2,412	100	2,743	100
Water														
Av. ft. Carried	159.5	......	6.1	......	139.6	......	108.1	......	59.3	......	212.7	......	355.7	......
Pump in House	327	2.0	225	6.3	21	1.5	7	0.2	2	0.1	62	2.6	10	0.4
Piped Cold	880	5.4	293	8.2	76	5.5	79	1.9	268	12.3	84	3.5	80	3.0
Piped Hot	117	0.7	23	0.6	31	2.3	23	0.6	9	0.4	7	0.3	24	0.9
Toilet*														
Outdoor	13,207	80.3	2,872	80.3	1,022	74.5	3,266	79.4	2,073	94.9	1,959	81.2	2,015	73.5
Indoor	327	1.3	85	2.4	35	2.5	34	0.8	*100	4.6	20	0.1	53	2.0
None	2,884	18.5	618	17.3	314	23.0	818	19.8	26	1.2	433	18.7	675	24.5
Kitchen Sink														
With Drain	610	3.7	181	5.1	99	7.2	73	1.8	174	7.9	43	1.8	40	1.5
Lights														
Lamps	15,604	95.1	3,429	95.9	1,288	93.9	3,992	96.9	1,876	85.9	2,341	97.1	2,678	97.6
Gas	118	0.7	52	1.5	26	1.9	22	0.5	1		9	0.4	3	0.1
Electric	754	4.6	127	3.6	76	5.5	104	2.5	308	14.1	81	3.4	58	2.1
Refrigeration														
Ice	1,764	10.8	266	7.4	206	15.0	301	7.3	570	26.1	270	11.2	151	5.5
Mechanical	133	0.8	39	1.1	34	2.5	8	0.2	19	0.9	6	0.2	27	1.0

* This figure is more than 100 per cent because some owners have a servants' toilet.

TABLE V. (Continued)

Conveniences	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
							WHITE OWNERS							
Total Homes	5,354	100	1,200	100	976	100	868	100	872	100	1,346	100	92	100
Water														
Av. ft. Carried	139.2	......	31.0	......	105.7	......	46.9	......	24.4	......	153.2	......	474.2	......
Pump in House	192	3.6	121	10.1	17	1.7	6	0.7	2	0.2	44	3.3	2	2.0
Piped Cold	644	12.0	221	18.4	65	6.7	48	5.5	192	22.0	74	5.5	44	47.8
Piped Hot	103	1.9	20	1.7	28	2.9	22	2.5	8	0.9	7	0.5	18	19.6
Toilet*														
Outdoor	4,539	84.8	1,036	86.4	744	76.3	772	88.9	812	*93.1	1,126	83.7	49	53.3
Indoor	256	4.8	70	5.8	29	2.9	30	3.5	75	8.6	16	1.1	36	39.1
None	574	10.5	94	7.8	203	20.8	66	7.6	0	0	204	15.2	7	7.6
Kitchen Sink														
With Drain	501	9.4	144	12.0	88	9.0	65	7.5	139	15.9	36	2.7	29	31.5
Lights														
Lamps	4,740	88.5	1,075	89.6	904	92.6	780	89.9	638	73.2	1,286	95.4	57	70.0
Gas	101	1.9	45	3.8	26	2.7	19	2.2	1	0.1	8	0.6	2	2.0
Electric	597	11.2	102	8.5	66	6.8	95	10.9	234	26.8	66	4.9	34	36.9
Refrigeration														
Ice	1,113	20.8	180	15.0	165	16.9	213	24.5	314	36.0	204	15.2	37	40.2
Mechanical	111	2.1	35	2.9	33	3.3	7	0.8	16	1.8	4	0.3	16	17.4

* This figure is more than 100 per cent because some owners have a servants' toilet.

TABLE V. (Continued)

Conveniences	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
WHITE TENANTS														
Total Homes	4,979	100	1,925	100	300	100	571	100	957	100	771	100	455	100
Water														
Av. ft. Carried	133.7	------	50.1	------	170.0	------	88.4	------	35.7	------	193.7	------	264.7	------
Pump in House	121	2.4	98	5.1	4	1.3	0	0	0	0	15	1.9	4	0.9
Piped Cold	202	4.1	72	3.7	9	3.0	9	1.6	75	7.8	10	1.3	27	5.9
Piped Hot	11	0.2	3	0.2	2	0.7	0	0	1	0.1	0	0	5	1.1
Toilet														
Outdoor	3,997	80.3	1,506	78.2	207	69.0	468	82.0	907	94.8	601	77.9	308	67.7
Indoor	62	1.2	14	0.8	5	1.7	0	0	25	2.6	4	0.5	14	3.1
None	920	18.5	405	21.0	88	29.3	103	18.0	25	2.6	166	21.6	133	29.2
Kitchen Sink														
With Drain	100	2.0	37	1.9	9	3.0	2	0.4	35	3.7	7	0.9	10	2.2
Lights														
Lamps	4,836	97.1	1,904	98.9	289	96.3	570	99.8	884	92.4	760	98.6	429	94.3
Gas	10	0.2	7	0.4	0	0	1	0.2	0	0	1	0.1	1	0.2
Electric	148	3.0	24	1.2	10	3.3	3	0.5	73	7.6	15	1.9	23	5.1
Refrigeration														
Ice	425	8.5	77	4.0	26	8.6	31	5.4	188	19.6	49	6.4	54	11.9
Mechanical	20	0.4	4	0.2	1	0.3	0	0	3	0.3	2	0.3	10	2.2

TABLE V. (Continued)

Conveniences	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
COLORED OWNERS														
Total Homes	701	100	62	100	41	100	418	100	24	100	84	100	72	100
Water														
Av. ft. Carried	176.5	------	59.9	------	132.4	------	116.4	------	35.4	------	368.3	------	346.9	------
Pump in House	2	0.3	0	0	0	0	0	0	0	0	2	2.4	0	0
Piped Cold	4	0.6	0	0	0	0	3	0.7	0	0	0	0	1	1.4
Piped Hot	1	0.1	0	0	0	0	1	0.2	0	0	0	0	0	0
Toilet														
Outdoor	589	80.0	55	88.7	28	68.3	351	83.4	24	100.0	73	87.0	58	80.6
Indoor	5	7.0	1	1.6	0	0	3	0.7	0	0	0	0	1	1.4
None	107	13.0	6	9.6	13	31.7	64	15.9	0	0	11	13	13	18.0
Kitchen Sink														
With Drain	5	0.7	0	0	0	0	5	1.2	0	0	0	0	0	0
Lights														
Lamps	700	99.9	62	100.0	41	100.0	418	100.0	24	100.0	84	100.0	71	98.6
Gas	2	0.3	0	0	0	0	2	0.4	0	0	0	0	0	0
Electric	5	0.7	0	0	0	0	5	1.2	0	0	0	0	0	0
Refrigeration														
Ice	70	9.9	2	3.2	4	9.8	35	8.4	10	41.7	12	14.3	7	9.7
Mechanical	2	0.3	0	0	0	0	1	0.2	0	0	0	0	1	1.4

TABLE V. (Continued)

Conveniences	Total		Acadia		Beauregard		Claiborne		Lafourche		Livingston		Tensas	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
COLORED TENANTS														
Total Homes	5,369	100	388	100	54	100	2,261	100	331	100	211	100	2,124	100
Water														
Av. ft. Carried	174.2	------	99.6	------	150.4	------	180.9	------	141.9	------	135.6	------	331.4	------
Pump in House	12	0.2	6	1.5	0	0	1	0	0	0	1	0.5	4	0.2
Piped Cold	30	0.6	0	0	2	4.0	19	0.8	1	0.3	0	0	8	0.4
Piped Hot	2	*	0	0	1	2.0	0	0	0	0	0	0	1	*
Toilet														
Outdoor	4,082	76.0	275	70.9	43	79.5	1,675	74.1	330	99.7	159	75.4	1,600	75.3
Indoor	4	*	0	0	1	2.0	1	*	0	0	0	0	2	0.1
None	1,283	23.9	113	29.1	10	18.5	585	25.9	1	0.3	52	24.6	522	24.5
Kitchen Sink														
With Drain	4	*	0	0	2	4.0	1	*	0	0	0	0	1	*
Lights														
Lamps	5,328	99.2	388	100.0	54	100.0	2,224	98.4	330	99.7	211	100.0	2,121	99.4
Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electric	4	*	1	0.3	0	0	1	*	1	0.3	0	0	1	*
Refrigeration														
Ice	156	2.9	7	1.8	11	20.4	22	1.0	58	17.5	5	2.4	53	2.5
Mechanical	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Less than 0.1 of one per cent.

The lowest estimate that has been found of the amount of water used by the average farm family per day is 23 gallons.[1] The United States Department of Agriculture gives the average daily consumption in the modern home as 40 gallons per person. To carry 23 gallons in a two-gallon bucket would require twelve trips to the well or, if the woman is strong enough to carry two buckets at a time, at least six trips. If she makes only six trips over the 160 feet that the water must be carried for the average Louisiana rural house, the six trips to the well and back to the house will total 1,920 feet, or a little more than one-third of a mile, that will be walked in one day by the person who carries the water for that average house. In a year, this would mean 130 miles of walking not counting the load. If water is not piped in, it must be brought in by hand labor for all purposes—bathing, food preparation, dishwashing, laundry (unless done in the yard) and house cleaning, as well as drinking. Needless to say, the family that has to carry all the water does not use so much as the family that can get it by turning a faucet.

An indoor toilet is, of course, dependent upon having water piped into the house. It is not only a convenience but is also a health provision.

The kitchen sink is one of the work centers where so many hours of the housewife's labor are spent that its presence or absence in the rural home is an important index of the family's sense of values.

Lights, of some kind, have been considered necessary since man began to be civilized. The leisure time of most families comes after daylight has gone; so the kind of lights used in the house helps to determine the kind and degree of recreation or of leisure-time occupation of a good many members of the household. Kerosene or gasoline lamps furnish a fairly good light for a limited number of persons; acetelene gas and, in some sections of Louisiana, natural gas furnish light more nearly over the whole room; electricity is the modern light which enables a family to use the evening hours for pleasure and profit.

Refrigeration is a great convenience and a means of saving food in almost any home anywhere. In Louisiana it is a real comfort, as well. In the hot days of summer, a drink of cold water is just about as pleasant a thing as one can wish and satisfies many a man coming in from his work, many a woman as she goes about her household tasks, and many a child, well or sick.

Each of these conveniences will be briefly discussed with regard to the total houses of the survey. Then the data for each will be broken down according to racial and tenure groups. The basic data are presented in Table V.

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[1] In the winter of 1924-25, a conference of farm men and women and extension workers was held in Auburn, Alabama, at which a program was drawn up. The committee on the Farm Home, reported in part as follows:

"By a study of living cost of 187 farm families in 1924, made cooperatively by the U. S. Department of Agriculture and the Alabama Extension Service, and by more than eight hundred answers made by farm women to a questionnaire sent out by the Alabama Extension Service, the following facts have been found: . . . 'That only 6.9 per cent of Alabama farm homes have running water, although 34 per cent of the women answering the questionnaire desired running water above any other improvement. The Department of Agrcultural Engineering has estimated that 11½ two-gallon buckets of water are used per day in the average farm home and are drawn from a well 30 ft. deep and carried 61 feet. This work is estimated to consume one hour of the farm woman's time, and in a year to have taken 46 of her working days. In carrying the water she has walked 100 miles. The above work is equivalent to unloading 22 cars of coal, of 30 tons capacity each.'" See "The Agricultural and Farm Home Program for Alabama," **Circular 77,** Alabama Polytechnic Institute, 1925. (by committees), pp. 37-38.

The study to which the committee referred was that of E. L. Kirkpatrick and Agnes Ellen Harris, "Living Conditions and Cost of Living in Farm Homes of Selected Areas of Alabama," **unnumbered mimeograph, 19,** Alabama Polytechnic Institute Extension Service, 1924.

Water for all purposes in the home is carried by the great majority of rural families in the six Louisiana parishes surveyed. Of the 16,403 houses in the survey, 2.0 per cent have hand pumps in the dwelling and 5.4 per cent have cold water piped into the house. This leaves 92.6 per cent of the homes without water available in the houses and for which all water has to be carried.

Of course, for some of these houses the water has to be carried a very short distance from a well or cistern in the yard; but for some it must be carried a long way, because the average distance from all the homes where it is carried is 160 feet. It takes a good deal of energy and determination to be clean under these conditions. The remarkable thing is that the same amount of both energy and determination have not been expended in pumping and piping the water to at least one faucet in the houses. Perhaps this desirable end would have been reached if the piping energy could have been expended by the same person as the carrying energy; but the determination necessary to keep the family clean with water that was carried might, if differently directed, have resulted in piping if it had not been an accepted custom to carry water. Once established, such culture traits have a remarkable ability to persist.

With only five per cent of the houses having piped water, of course most of the toilets of Louisiana rural homes are out-houses. Of all the houses of the survey, 80.3 per cent report outdoor toilets, 1.3 per cent report indoor toilets, and 18.5 per cent report none. Some of this lack can be accounted for by provision of one toilet for more than one tenant house, where houses are very close together; but good "quarters" provide a toilet for each house; so in most of these cases, it is a matter of lack of sanitary facilities. There are a few houses that have an indoor toilet and another outside, for the servants, making a total of more than 100 per cent. The lack of toilets for so many houses is the worst feature of the Louisiana rural homes with regard to conveniences. The modernization of the rural home, as indexed by sanitary indoor toilets, has only begun in Louisiana.

A kitchen sink with a drain relieves the housewife of a great part of the labor of carrying water out of the house. This convenience is provided, however, in only 3.7 per cent of the rural homes of the six parishes surveyed, not even all those homes that have water piped into the dwelling. If the family cannot afford piped water and a sink, the woman should carry water and do it cheerfully; but a sink costs so little money! It would seem that the owners of at least the one-fifth of the houses of the survey that could afford paint for the house might have afforded a kitchen sink. The conclusion is that this convenience for those who perform the household work has not been demanded by the standard of living, the folkways of the rural groups. This certainly applies in those houses where the decision was not entirely a matter of having the money to spend.

The prevailing practices in this matter of conveniences, like many other features of housing among rural families in the South, are rooted, at least in part, in the poverty of the farm people following the Civil War. With no money, no stock, no laborers, and insufficient food supplies for health and energy, generations of southern agricultural families have not been able to keep up the houses that they already possessed. Through necessity they developed habits of bearing inconveniences, along with other hardships; and through cultural compulsion the trait has persisted even past its necessity.

Lights are more prevalent than any other conveniences in the Louisiana rural homes, if lamps may be considered efficient. Most of the homes, 95.1 per cent, use lamps—kerosene or gasoline; 0.7 per cent use gas, and 4.6 per cent are lighted by electricity. A few of those having gas or electricity still use lamps in parts of the house and so have two kinds of lights. Only an infinitesimal number have no lights. It is somewhat surprising that a few houses have electric lights that have not a kitchen sink. Piped water, however, is one of the things that the great majority of the families became accustomed to doing without[1] while there was no money to put it in and before they acquired the knowledge that some people of similar station in life had it. On the other hand, electricity is a newer thing and when the opportunity to wire the house for lights came along, some families that could afford it had their houses wired; they had not realized that they could afford the sink with piped water, which would have cost less but which they were accustomed to doing without. Some credit for the slightly higher percentage of electricity than of sinks may be given to the salesmen employed by power lines.

It was in the spring of 1934 that this figure was reported—4.6 per cent of the rural houses lighted by electricity. Since then, particularly in the winter of 1936-37, through the activity of the Rural Electrification Administration, a good deal of interest has been aroused in electricity for farms. At present (in the spring of 1937) that activity is still in the promotional stage in Louisiana. And additional farmers have not yet begun to read by their new electric lights.

The last of the conveniences considered in this study is refrigeration. In this matter, Louisiana does better than in the other conveniences, except lights. The lights are lamps, but cleaning lamps does not entail the work of carrying water. Even though the percentage of rural houses with refrigeration is low, it is higher than the percentages of houses with piped water, with kitchen sinks, or with any lights other than kerosene or gasoline lamps. There are 10.8 per cent of the total houses of the six parishes with ice refrigerators and 0.8 per cent with mechanical refrigerators. During Louisiana's hot summers, refrigeration is a great help in having cool water to drink and in keeping food fresh, with the results of economy and a greater degree of of adequacy in the diet. Because this is not a country of springs or of cellars and because a good many of the cisterns are above the ground, families who have no refrigeration cannot easily keep food from spoiling or in some cases have cool water to drink. The survey data show that 88.4 per cent of the rural families are in that unfortunate position.

When the data are considered by parishes, it is seen that in the matter of conveniences, Lafourche is at the head of the six parishes; Acadia and Beauregard are about average; and Claiborne, Livingston, and Tensas are below the average.

When the data are broken down according to the racial and tenure categories, it is seen that the only group that is living on a fairly high plane is the white owners. In all the conveniences listed above, the percentages of the totals for the white owners are above the percentages of the grand totals for the six parishes. The percentages for all the other groups, white tenants, colored owners, and colored tenants, in all the conveniences are below the totals with two exceptions. White tenants, although they have fewer homes with piped water, are above the average in percentage of homes with pumps. The other exception is more significant; the colored owners have a higher percentage of toilets than the total homes for the six parishes; so in this one matter of toilets, owners, both white and colored, are above the averages for the state.[2] In all other conveniences, white owners are the only group that, as a whole group, are above the average.

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[1] A Minnesota farm woman is quoted as saying, "My boy came home this spring from the School of Agriculture and the first thing he did was to install a drain in the kitchen. I never knew how much extra work it required to carry the dish water, until this convenience was placed in my kitchen." See G. A. Lundquist, Special Bulletin No. 71, University of Minnesota Agricultural Extension Division, 1923, p. 5.

When the white owners of one parish are compared with those of another parish and with the total of white owners for the six parishes, it is seen that the parishes fall into three groups. The percentages of all these conveniences among white owners are highest in Lafourche and Tensas; and they are lowest in Beauregard and Livingston. This grouping of the parishes would seem to indicate that conveniences in the rural homes are more in use among owners of plantations than among owners of smaller farms.

In general, the significant differences in conveniences seem to be between white owners' homes and homes of other groups and more especially between white owners' homes on fertile soil and those on poorer land. That the "big house" on the cotton plantation is best equipped with conveniences of the rural houses in the state is shown by the survey data. The percentages are highest among the white owners of Tensas, who are big cotton planters, and next highest among the white owners of Lafourche, where there is the mixture of cane plantations and small truck farms. These two parishes of fertile soil show the white owners' homes far above the other groups in the survey in the matter of conveniences.

In summarizing the data regarding conveniences in the rural homes of the six surveyed Louisiana parishes, a few facts stand out. First, the rural housing in these parishes is on a lower plane than any one interested in social welfare could wish. Second, the conveniences which make the poorest showing are water piped into the dwelling, a kitchen sink with a drain, and the toilet. Third, it would seem that this lack of conveniences is due to habit of doing without (cultural compulsion), as well as to financial inability. This seems to be evidenced by the fact that more houses are without the kitchen sink, a convenience that has been accessible longer and for less money, than electric lights, which are comparatively recent and costly in rural districts. Fourth, it is only among white owners that conveniences are present in a fairly high percentage of houses, and then only among owners in the fertile delta areas of the state.

CONCLUSION

Consideration of the data on rural housing in Louisiana has led to certain definite conclusions. As the significant facts and associations were summarized at the end of each section, those facts will not be repeated at length here. Rather will this conclusion deal with a few generalizations, and because one of the objectives of this study was to lay some definite part of a foundation for the Louisiana home demonstration program, some relationships between the data presented and the Extension activities will be barely indicated. The outlining of the program itself is another study.

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[2] It is possible that the C. W. A. program of building sanitary toilets had some bearing on this high percentage of toilets among colored owners. It is more probably explained, however, by the high type of Negroes who own their homes, for the C. W. A. program would have increased the percentage among white and colored tenants along with colored owners.

1. The body of published information about rural housing in general is very small. In Louisiana, it is so meager that only one publication has been found. The schedules of the federal housing survey present available data, awaiting analysis.

2. Home ownership, over the state generally, is higher on poor soil than on fertile soil. Where it is high on fertile soil, it is associated with truck farming or with French culture of the population which includes a tradition of owning a little land.

3. Under the present system of agriculture, plantation owners do not make extensive improvements on the houses of tenants who (1) are not supporting the additional outlay, (2) are extremely mobile and may move away within a year or two, and (3) have for generations lacked the cultural background that is necessary for taking care of a house with adequate room and modern conveniences. Furthermore, the owners on poor soil have, under the present system, in many cases, hardly been able to hold possession of their homes even without the added expense of making improvements.

4. The standard of living is not necessarily based entirely upon ability to pay. "Desires for higher standards of living and the ability to pay must go hand in hand." There is a lag in providing adequate space and installing conveniences in the rural homes of the state that can be explained only by cultural compulsion. The percentage of conveniences is higher among the white owners than among any other racial or tenure group, but even in this group it is lower than it should be for the continuing development of rural life.

5. The data regarding age of the rural houses established the existence of a certain tradition of pride in ownership that can be called upon to counteract the inertia that has made rural people accept, without questioning, the inconveniences of their homes. This pride in ownership is one of the foundation stones upon which a program of rural home improvement may be built.

6. The home demonstration agent who understands the housing conditions of her parish and the economic and social background of its people, can advise farm families regarding the improvements that are within their reach. More especially, she can influence the families to adopt sanitary practices and labor-saving equipment that are more dependent upon desire than upon financial expenditure. This will require education over a period of time. If, however, the ability to measure the value of expenditure by the family satisfaction derived is so directed as to improve the rural houses in Louisiana, perhaps a contribution will be made toward a higher standard of living for the farm families on whom the city and country depend.

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